FACULDADE DE ENGENHARIA DA UNIVERSIDADE DO PORTO

Innovation in a Software House: How to create a culture of permanent innovation based on our culture, values and knowledge' sharing policies

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Abstract

The modern business context force companies and organizations to continuously evolve under the threat of losing market share and consequently turn-overs putting the company or organization under the situation of striving to survive. To avoid this dangerous situation and taking into account the fact that the business context reveals itself as being highly competitive and unpredictable, companies need to find a way to defend themselves from new-comers and at the same time increase its market share. Regarding the opinion of many famous authors, experts and consulting agencies, innovation is perceived to be the correct path in the attempt to keep the current clients of a company but also in the attempt to conquer new ones.

In order to obtain good results, every part and piece of the company must play a special part in the innovation process and perform a team work guided in the way of innovation in order to shape the process in a coordinated, efficient and result-oriented thing.

The quality of the processes of a company and consequently in the final products is a synonym of getting the right way to obtain corporate success. Every company with its structure, processes and resources is designed to obtain a single purpose: high quality performance. It is now easy to state that poor structures and poor processes lead eventually to bad performances. Using the above as a base of work and knowing how important innovation is, it is fundamental to understand what are the determinants of innovation available in the company that is going to be studied currently available and others that may appear in the future and how they can be used to boost the innovation process in order to achieve products of high quality. Human resources policies regarding physical and social environments are going to be implemented with the goal of creating new determinants of innovation in the company and improving the existing innovation process in order to create a culture of continuous innovation.

This report expresses the state of the art in the topics of innovation process, metrics of innovation, determinants of innovation and human resource policies with the goal to create and boost a culture of permanent and daily innovation. Besides that, it will expose the impact of certain policies implemented taking into account the initial state of the company's innovation process by applying the proper innovation metrics.

Resumo

A atual conjetura económica obriga as empresas e companhias a uma constante evolução sob o risco de perderem as suas respetivas quotas de mercado e, consequentemente, os seus retornos financeiros colocando-se numa posição de pura sobrevivência. Para evitar esta posição perigosa numa altura em que o contexto empresarial atual se revela altamente competitivo e ao mesmo tempo imprevisível, as empresas têm de se defender constantemente das entradas de novos rivais e ao mesmo tempo tentar alargar as quotas de mercado. Segundo inúmeros estudos de autores de renome e de agência de consultadoria, a inovação é tida em conta como sendo cada vez mais o caminho a seguir na tentativa de preservação dos clientes de uma empresa mas também na tentativa de angariação dos mesmos.

De maneira a obter bons resultados, todos as componentes de uma empresa que têm um papel preponderante no processo de inovação devem ser vetores com a mesma direção e sentido com o objetivo de tornar esse processo em algo coordenado, eficiente e com resultados de excelência.

A qualidade que é imposta em todos os processos de uma empresa e consequentemente nos seus produtos finais é um sinónimo de acerto na escolha que foi feita enquanto se procura o sucesso empresarial. Cada empresa com a sua estrutura, processos e recursos foi desenhada para atingir um fim: a performance de excelência. Assim sendo, é de fácil constatação que más estruturas, maus processos levam a uma má performance. Tendo isto como base e sabendo da importância crescente dada à inovação, é importante perceber na empresa a estudar quais são os atuais vetores de inovação que a empresa possui e, principalmente, como é que esses vetores e outros possivelmente criados ao longo do trabalho a ser desenvolvido podem ser orientados para atingir um processo de inovação de qualidade elevada. Essa criação de outros vetores passa por perceber como é que é possível, através da implementação de políticas de Recursos Humanos ao nível do ambiente físico e social que se vive nas equipas de desenvolvimento, melhorar o atual processo de inovação e criar uma cultura que seja posta em prática diariamente de inovação.

Este relatório exprime o estado da arte atual no processo de inovação, nas suas métricas, determinantes e nas políticas de recursos humanos com o objetivo de criar e fomentar uma cultura de inovação permanente e diária. Para além disso, exprimirá o impacto de certas políticas implementadas tendo em conta o estado inicial do processo de inovação na organização e usando para isso as métricas de avaliação adequadas.

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Pedro Filipe Pinto Simões

” Who seeks shall find”

Sophocles

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Abbreviations

CDQS	Creativity Design Quick Scan
CO	Co-ordinator
CF	Completer Finisher
IMP	Implementer
IWB	Innovative Work Behaviors
ME	Monitor Evaluator
PL	Plant
RI	Resource Investigator
SH	Shaper
SPI	Self-Perception Inventory
TCI	Team Climate Inventory
TW	Team Worker

Chapter 1

Introduction

1.1 Work Context

The organization in which the study was made in a company that operates in nineteen different countries from four different continents and that its main focus is developing and commercializing software solutions and business process integration tools that boost the management process throughout an entire organization. With this range of products, the company is able to provide solutions to Small, Medium and Large companies as well to the Public Administration sector. In a ranking promoted by Growth Plus, the software house was considered one of the 500 largest European companies with greatest growth potential. This award was mainly attributed due to the effort that the company does on a daily basis to provide to its customers solutions made with the state of the art technology and that are truly able to respond to the organization's needs in the present and in the future.

More than 40 thousand companies that represent a universe of more than 120 thousand users use the company's software solutions to keep track and better manage the daily activities of their business processes. Big clients like Chicco, Deutsche Bank, DHL, EPSON, GALP, KPMG or Shell provide a range of economic sectors that turns out to be more than enough to realize the importance that is given to having a big portfolio of heterogeneous companies. Industries like Construction, Health, Retail, Electronics, Transport and Logistics, Banking and more are all targeted as possible clients.

The company's mission is a clear statement of the compromise that it has with the future of organizations by having a bold and enterprising spirit that allows that each worker has the means to help the company find innovative solutions that fill the needs of the clients:

- " Driven by the desire to surpass its own achievements as it strives for excellence in every aspect of its business, constant and permanent innovation is the company's ultimate mission. And we look to the future for inspiration as we seek routes that will lead us to success in our lofty ambition. This being the major challenge that causes our entire vast team to move as

> one, we stride passionately towards the hurdles of the present with our eye ever focused on solutions that anticipate the future needs of organizations. The bold, ambitious, enterprising spirit of the company's team embodies the very identity of the company and its vision. The union between the Sun and the Butterfly bring the spirit of the company to life: a spirit of Youth, Ambition, Creativity and Freedom. Every day, as we go about our work, we focus on a single goal – to explore and develop new technologies that will lead to the launch of innovative solutions, and which reflect the state of the art of the sector."

Taking into account the mission, it is fairly easy to understand that innovation is in the organization's genes. The main goal is to deliver to the market innovative management solutions that boost the productivity and competitiveness of current and future clients. Furthermore, the software house is also keen on providing products with high levels of quality to its customers. Obtaining the ISO 9001 certification and the CMMI level 2 certification that assures that the all major phases in the software engineering process from architecture, development, maintenance, usability, documentation to quality control are all being made by implementing a set of good practices.

The map of products developed is all related to management solutions and tools that integrate the numerous business processes of an organization. The solutions are designed taking into account the specific requirements of the client and are characterized by its robustness, reliability, integrity and security. Finally, the company also has also services of consultancy and training.

In order to conclude, it is perfectly clear that the organization is focused on taking the path of innovation in order to tackle more markets and obtain better, more responsive and intuitive products.

1.2 Motivation and work goals

High competition is the main characteristic of the today's modern business context. That high competition between organizations is a natural struggle that exists in a business environment that reveals itself as being more and more open to newcomers that try to create new target markets by creating new needs while innovating in a disruptive way or try to do things that are already done but in a different way that betrays itself as offering more quality, agility of processes and intuitiveness to the final clients or consumers of the product developed or service offered. That high competition is driven and galvanized by:

- the deregulation of the markets with the benefits of raised level of productivity, efficiency and lower prices but with the harm of not creating a level playing field for all competitors and not protecting;
- the consumer empowerment in which a consumer or groups of consumers are able to demonstrate to organizations their needs, demands and requests when they are in the process of decision-making;
- the emerging technology that affect directly all kinds of markets and that influences deeply the quality of business processes;

- the globalisation of the economy, a sort of irreversible trend that increased in a huge way the interdependence of national economies by augmenting the exchange between borders of products, services, goods, capital and most importantly technology;

- the uncertainty of economic circumstances that is revealed by the increasing number of countries that are in recession and in need of some sort of economic programme sponsored by the higher financial authorities;

- the rapid product development that was promoted by the success that innovative engineering processes had on the way in how companies design and develop their products guaranteeing ensuring that those processes are more cost-efficient and allow a shorter time-to-market. [EBAT13]

Taking into account the aspects mentioned above and realizing that software engineering is an activity that is considered to be knowledge-intensive due to the constant access and manipulation of huge amounts of knowledge and technology-driven cause it is the main foundation of the whole process, it is fair to claim that software industry is constantly affected by the whole environment that surrounds it. [RA02] With this being said, it is fairly easy to state that quality in all the processes of the company and consequently in the final product or service delivered is fundamental for the success of the company but no longer enough to generate good turnovers. [RA02]

For the sake of obtaining good results, the company needs to adapt its current strategies and processes to the demands of the competitive market. A poor performance is a direct consequence of a poorly designed organization and structure. High levels of performance are verified when technologies, processes, strategies, tools, business models, reward systems and structure are all vectors that point towards the same direction in a coordinated and harmonic way. [Vid13]

In the interest of getting more and more success, an organization needs to develop innovative products either by incrementing the quality and features of the ones currently in the market or by disrupting the market with some brand new product. Besides that, an organizations needs to innovate in its work processes allowing each and every worker to exchange information and knowledge easily and to take part in a big innovation process by making sure their ideas are heard. According to a study made by Capgemini Consulting, the absence of a well-articulated innovation strategy is by far the most important constraint for companies to reach their innovation targets, followed by a lack of understanding of the external environment. The majority of companies do not have an explicit strategy that allows high levels of innovation and at the same time, innovation is considered to be an emerging functional area within organizations as more and more importance is being given to innovation as a way to gain higher market-share and higher profits. [Mil12]

With that being said, it is easy to understand the concern shown by the organization to the big problem or topic that is innovation. A company from the software industry needs to show constant innovation in the developed products and in the services that provides. The company is already paying high degrees of importance and attention in this matter. However, this is an important time interval to do a full analysis of the innovation process in the company, the advantages and

disadvantages of the current model, the opportunities that exist with the resources that are currently available and some possible changes to improve the efficiency of the whole process.

Concerning the objectives for the work that is going to be developed, it is expected to discover the answer to some difficult questions related to innovation in a software house:

- What kind of policies should be applied to create a culture of innovation on a daily basis? How to create correct environments to boost innovation?
- In a Human Resources management point of view, what kind of policies should be applied?
- How to create the correct mood to maximize the employees' and company's innovation potential?
- What is the impact of the balance of team roles in the climate for innovation?
- What is the impact of the physical environment in the innovation process of an organization?

Answering these questions using the company as a *Petri* dish is the way that is going to be taken in order to achieve a useful and important work that is able to be used in the future as a guidance and help in the problems of innovation in a software house.

Regarding the expected outputs of the work, the main objective is to produce a report with guidelines and suggestions to boost the innovation within the organization. In this report, it is going to be included: an analysis of the current innovation process of the company that involves a diagnosis of the problems encountered in the company and the opportunities that the organization already has and that are being under-explored; a benchmarking of human resources policies which consists of a gathering of the best practices in the IT business sector and in other economic activities that enables and improves the innovation process; a list of recommendations with possible changes to work environments and methodologies that are being used currently in the company and a possible redesign of the actual employee's work flows to allow more exchange and share of knowledge and information.

In the matter of methodologies that will be used to develop the whole work process, there are a few that can be easily pointed out:

- Interviews with key personalities of the company to understand the current state of the organization's innovation process. In this methodology, the whole company's organizational chart from top to bottom is going to be interviewed. With this being said, it is intended to interview top executives, human resources leaders, project managers, team leaders and developers;
- Focus groups with representatives from the whole organizational chart in order to think and study the problem of innovation in the organization. With the thoughts and perspectives from a heterogeneous range of participants, it is expected to identify in a clearer way the problems of the organization and possible solutions to those problems;

- Ethnographic observation to better understand the culture and habits of the Research and Development teams and management bodies and to perceive in a natural work environment and situation how the work is done and the knowledge and information is exchanged or shared;
- Evaluation of the existing innovation determinants in the company and implementation of measures and polices to boost innovation according to those existing determinants;
- Diagnostic of the physical environment for innovation;
- Evaluation of the developers innovative work behaviors;
- Evaluation of the team's climate for innovation and possible correlation with the balance of team roles within the team.

In the next chapter the state of the art on the innovation process in a software house is going to be exposed followed by the work plan.

1.3 Dissertation's Structure

In addition to the introduction, this dissertation has more four chapters. In the chapter 2, the state of the art related to the innovation and the impact of the social and physical climate in it is presented.

In the chapter 3, the problem and its initial conditions are presented. In this chapter, it is exposed the history of the innovation process of the organization and the current struggles that prevent a better outcome of that process.

The experiment made in the organization and the evaluation of that experimented is presented in this chapter 4.

Finally, the conclusions of the work made and the topics for future work based in the same ideas are presented in this chapter 5.

Chapter 2

State of the art

2.1 Innovation and its role in the organization

2.1.1 Definition of innovation

In order to better understand the whole complexity of the problem that is going to be addressed, it is extremely important to define and truly comprehend the meaning of the most important keyword of this work and how it can be related to software engineering and to the study's software house.

During the process of literature review, it was perfectly clear that innovation has a lot of different definitions depending on mostly the context of the innovation. Although it is considered to be a keyword that easily has a collection of possible interpretations, the majority of them concerning product/service innovation all refer two main ideas related with whole innovation process: the discovery of a brand new thing that can be an original product/service and its commercialization as in an integration in a product/service to be sold or delivered or opening of a new market. A few examples of innovation definitions can be read to better understand the previous statements:

- "Innovation has two parts: the generation of an idea and the conversion of that idea into a useful application." [EBAT13]
- "Innovation is a process that begins with an invention, proceeds with the development of the inventions, and results in the introduction of a new product, process or service to the market-place." [AA87]
- "Innovation behaviour can be defined as all individual actions directed at the generation, introduction and application of beneficial novelty at any organisation level." [KFDJW03]
- "'Organisational innovation has been consistently defined as the adoption of an idea of behaviour that is new to the organisation. The innovation can either be a new product, a new service, a new technology, or a new administrative practice.'" [Hag99]
- "Product innovation relates to the introduction into the market of any new or significant improved products (goods or services). Process innovation: relates to the introduction of

any new or significantly improved production process (but not delivery, unless this is integral to the process of production/ delivery). Delivery innovation: relates to the development of changes in how the enterprise delivers its products (goods or services) to its customers. Examples include introduction of just-in-time delivery, consumer e-commerce, introduction of new or significantly improved home shopping services. Strategic innovation: relates to the implementation of new or significantly modified business strategies. Examples include targeting different markets, implementing new or significantly modified missions. Managerial innovation: relates to the implementation of new or significantly modified managerial techniques. Examples include the introduction of knowledge management practices, quality circles. Marketing innovation: relates to the implementation of new or significantly modified marketing strategies and concepts. Examples include the introduction of new or significantly improved marketing methods" [EBAT13]

- "Innovations vary in complexity and can range from minor changes to existing products, processes, or services to breakthrough products, and processes or services that introduce first-time features or exceptional performance." [DDC08]

It is extremely important to state that the majority of experts believe that innovation is both perceptual and conceptual and so in the process of innovation it is a key factor to go out of the organization and look, ask and listen using both sides of the human brain as team to build a proper innovation process. The innovation has to fulfil certain needs and expectations in order to satisfy an opportunity. Starting to be small, effective innovations builds itself up along time and in the end always receive the compliment of being simple and obvious.

2.1.2 Types of innovation

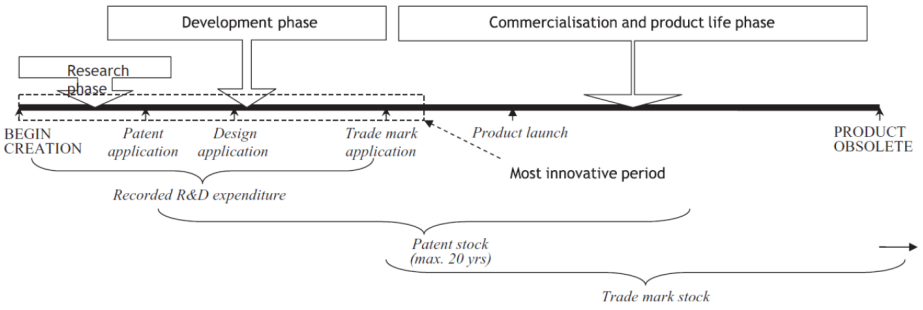

Figure 2.1: Product innovation (Jensen and Webster 2009)

Innovation can be divided in divided into four different types of innovation depending on the main "object" of novelty. The process of creating and introducing new products either being totally new in terms of concept and technology used or just significantly improved in the structural and performance point-of-view by adding new features and interfaces is called **product innovation**

as can be seen in Figure 2.1. **Process innovation** refers to the implementation of a new design, analysis or development method that modifies deeply the way that products are created and made. Figure 2.2 illustrate the process innovation.

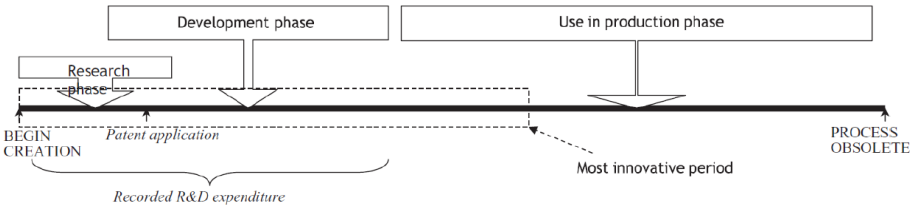

Figure 2.2: Process innovation (Jensen and Webster 2009)

Implementing new or significantly modified marketing methods, strategies or concepts in the way that the product or service is made concerning the well-known marketing mix is called **market innovation**. Adopting new strategies related to packaging, placement, pricing or promotion can lead to the opening of new market opportunities. Utilization of a new organizational method in the firm's business practices, relations with the external community or workplace environments is called as **organization innovation**. [EBAT13]

Consulting agency Accenture who already did a great number of surveys concerning innovation and the impact of innovation in the organizations divides the concept into three different kinds of innovation: incremental, platform and breakthrough. **Incremental innovation** do not change the product or service dramatically and so does not offer to the final customer superior advantages or benefits but it is considered essential as it is the way that a company has to defend itself against its competition. It also can be perceived as renovation instead of a major innovation. When an innovation delivers superior customers benefits and drive market growth and has the need to be sustained in a competitive advantage through branding, pricing strategies or technological advances is called a **Platform innovation**. Finally, the **Breakthrough Innovation** are the market-changing innovations that deliver new benefits to customers while creating a new market that they're also able to dominate for a period of time. In Figure 2.3, it is possible to see the market impact of the different types of innovation according to their competitive advantage and consumer valued benefit. [Acc11]

2.1.3 Degree of novelty of innovations

Innovation can also be differentiated by the how original or novel they are. This differentiation is important to understand because each degree of novelty implies different organizational growths and moreover different processes of market introduction. Based on novelty, there are four types of innovation: being **new to the firm** is the minimum level of novelty in innovation and is generally the adoption of a new practice, strategy, methodology, technology, process or product that is new to the organization that adopts; when a company is first one to introduce the innovation in the market it is called **new to the market**; when there is a greater degree of novelty than new to the

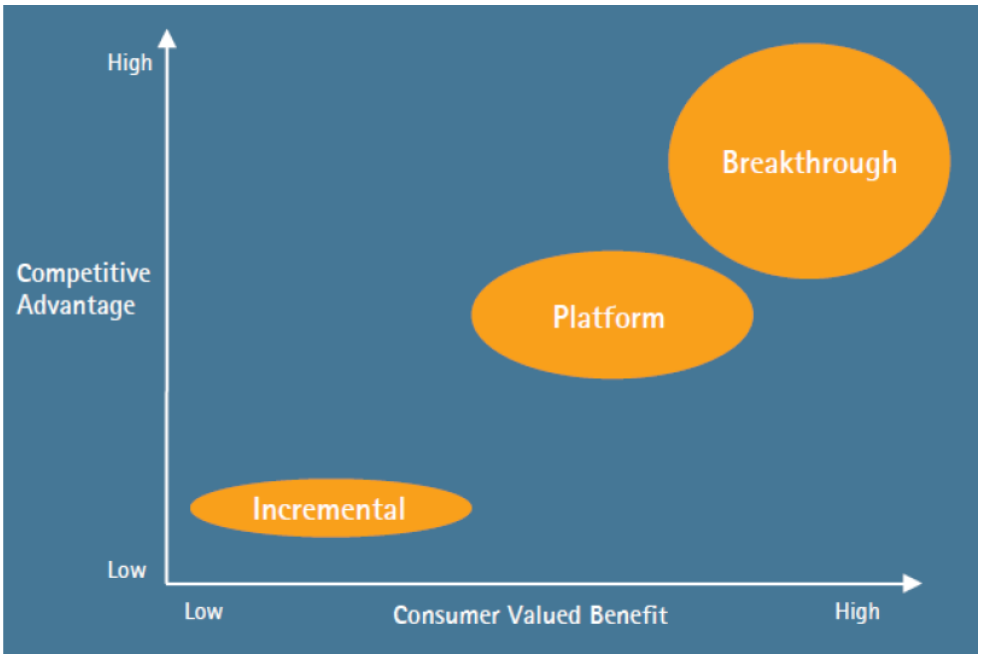

Figure 2.3: Market impact of innovations (Accenture 2011)

market and include innovations in all markets and industries all around the world is designated as **new to the world**; when the innovations are new to economic sector of the company responsible by the innovation is called **new to the industry**.

2.1.4 Impact of innovation

Probably the most important way to categorize innovation is by the impact that it was on the market and the change in the underlying technology: when the innovation brings small or minor changes in technology based on existing platforms that turn out to deliver low incremental benefits is called **incremental innovation**; there is a **market breakthrough** when the core technology is the same as existing products but the innovation provides higher customer benefits per dollar; when there is not an increase of the benefits per dollar to the customer but the technology used is significantly different than the rest of the existing products is called a **technological breakthrough**; disruptive innovations with first time features or high levels of performance with the use of different technology with a cost that creates new markets or changes the existing ones is referred as a **radical innovation**.

2.2 Nature of the process

Innovation is considered to be an iterative process where a set of stages must accomplished and fulfilled in order to get a final result of excellency. The major activities of the process consists of idea adoption or generation, the development of products or services and the introduction of those

products or services to the marketplace. Besides these activities, creation of knowledge by application, recombination or extension of the existing knowledge and implementation of processes in the organization are considered major activities of the innovation process as well.

2.3 Sources of innovation

"Where does innovation come from?" is a question that is regularly asked and that a few people are able to answer. Empirical knowledge states that innovations comes from a flash of genius but more and more experts believe that as innovation is considered to be somehow of a specific function of entrepreneurship and so it has better chances to be successful if it is a consequence of a search with a high degrees of purpose and consciousness. It is important to explore the several internal and external sources of innovation. [Dru02]

2.3.0.1 Internal Sources

The first, simplest and easier source of innovation is the **unexpected innovation**. If the manager and executives of a company show themselves open to failure, they can end up realizing that both unexpected successes and failures are productive sources of innovation opportunities due to the fact that the majority of business leaders dismiss and disregard them. There are examples of failed products that ended up being innovative products by creating new markets and changing the existing ones at that time from IBM to General Motors. It is important to keep a mind set in which problems and opportunities are given the same amount of attention. [Dru02]

Incongruitiess within the normal logic or rhythm of a process, incongruities between economic realities or incongruities between expectations and results open up possibilities for innovation and most of the times all that it needs to happen is a shift of the managers' and executives' viewpoint to realize that opportunity to innovate. [Dru02]

A great source of innovations comes from the **needs of a specific process**. For example, the linotype was a machine purely created with the reason to make it possible to produce newspapers in a high speed and in a large volume and modern advertising in the newspapers was a response to a need to distribute news almost free of charge with the profit coming just from the marketing gains. [Dru02]

Changes in the industry and market structures represent a great source of innovation because experts believe that when an industry grows quickly its structure changes and established companies tend to concentrate their efforts in preserving what they already have and do not counter attack new comers leaving them to gain fast growing market segments. [Dru02]

2.3.0.2 External Sources

Demographic events are one of the most important occurrences and yet they are neglected most of the times by politicians, business executives and entrepreneurships. In those demographic changes relies a great opportunity of innovation due to the fact that the neglected demographic events can

be explored and produce great recompenses. Changes in the numbers of people and in their age distribution, professional occupations, geographic location and education provide rewarding and least risky opportunities of innovation. [Dru02]

The old question of "The glass is half full or half empty?" represents the phenomenon of how **perception** influences the human choices and general behaviour. Thinking of the health care all over the world, the quality of the service provided increased dramatically in the last years but the concern for severe diseases as cancer or heart disease has also increased creating business opportunities from health care magazines, gyms, exercise classes or even healthy food restaurants. [Dru02]

Considered to be the most famous type of source of innovation, **new knowledge** that could be scientific, technological or social always attracts to itself lots of publicity and money. An innovation of this type usually demands combinations of multiples types of knowledge and involves a long lead time to be fully implemented. [Dru02]

2.4 Challenges and opportunities of an innovation process

When talking about innovation and all the efforts that are inherent to the implementation of innovations processes in a company, it is important to discover the answer of a legitimate question: is it worth it to invest in innovation in the software industry?

Accenture, a global management consulting, technology services and outsourcing agency conducted a study in 2008 in which 601 senior executives where surveyed about the state of the innovation process in their companies. The majority of the companies surveyed are assuming that innovation is a fundamental part of their business strategy. In fact, 44 percent state that innovation is used to increase and drive high growth rates and renovate the core business.

Although innovation is considered to be a top priority by the companies surveyed, the study discovered important barriers for implementing a successful innovation agenda. Being able to show good results through the proper use an innovation process is considered to be a set of phases that is hard to execute and sustain. The survey concluded that frequency, pace and speed of innovation were considered to be attributes commonly cited as areas of weakness. Besides that, the process of changing the culture of an organization and reducing the time to market are both activities that represent serious challenges for organizations concerning their innovation goals. Furthermore, one of the key finding is related to the general satisfaction with the innovation performance of the companies that is considered to be low in the skills of being consistent, repeatable and with high-impact. With this being said, it is imperative that the organization has created a vision for innovation and ownership and accountability for the execution of the entire process. Giving the opportunity for the innovation program to be a success, is to give to the program the same treatment as other business disciplines by providing the necessary resources and tools and demanding that performance goals are achieved and measure with a proper set of metrics. [Acc08]

According to another study from Accenture, companies tend to ignore the strategic, operational and opportunity costs associated with the innovation spiral and consequently overvalue and

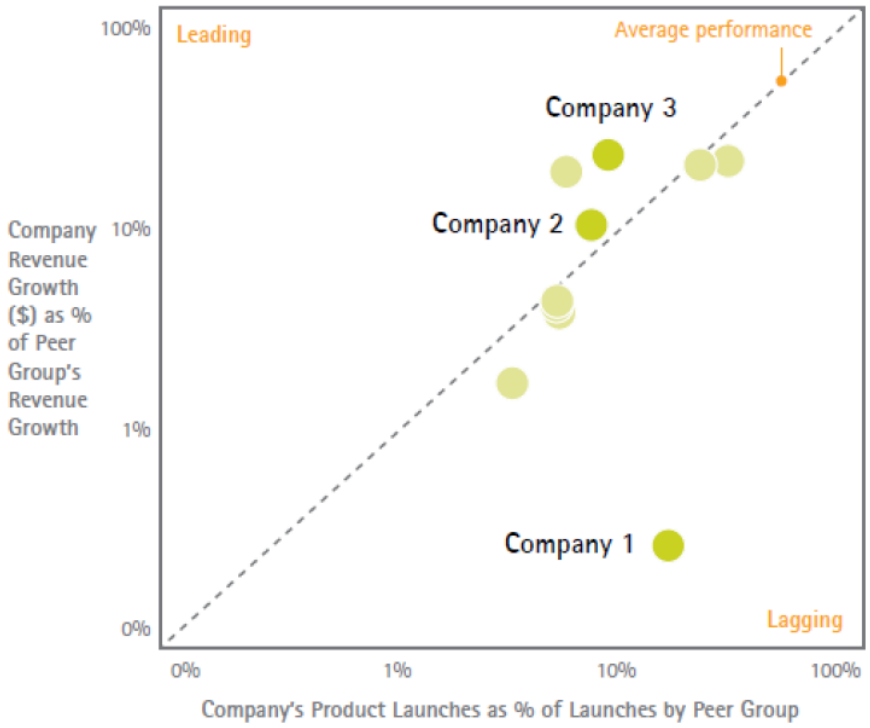

Figure 2.4: Comparison between types of innovations (Accenture 2011)

overrate their simply incremental type of innovation. Two negative spirals, strategic and operational, are the cornerstones of the innovation spiral and have to be taken into account to make sure that the company does not immerse itself in one of them or both at the same time. A innovation program that reveal itself as unsuccessful lead to a decrease of profitable growth but also lead to bad market positioning because of the fact that the company is now forced to play a cost game with its product and end up losing market share. This consequences are followed by worst one because the company is obliged to reduce its Research and Development budget and finishes investing less and less in product differentiation. This vicious circle reveals itself as being the first 'death spiral'. Companies generate higher growths with platform or breakthrough innovation than with incremental innovation as can be seen in Figure 2.4 with Company 1 launching more products than Company 2 and Company 3 but not being able to get more revenues due to the fact that it only invests in incremental innovations.

The other negative spiral is the operational spiral where companies often neglect the weight of innovation into their whole value chain from sourcing team, manufacturing to reverse logistics. Either being successful innovation or failed projects, both consume equally company's resources and if the company does not give consideration to those costs, it can end up in a spiral where innovative products grab the resources and old offerings hold their position in the portfolio. [Acc11]

The economic sector related with technology is changing practically almost every day and this fact has its consequences. Innovation must be in the order of the day for the company to obtain

good results and survive. With this being said, it is still important to consider the possible negative side-effects of innovation in the harmony of the teams of the company: innovation could increase the risk involved in a project and cause future problems, can disrupt the harmony of the team due to the difference between the people abilities, can reduce coordination in a team or cause problem if there are no organizational morals. So for all the opportunities that innovation brings,there are a few risks and challenges to be taken care of and these are one of the reasons for a solid and consistent innovation process. [Asi13]

2.5 Human resources strategic policies and their impact in the innovation capability of an organization

The innovation process of an organization can be affected by several factor both internal and external to the company.

The majority of the literature that is available related to this topic focused in the human resources strategic policies and in their impact in the financial results, company's productivity or in the business volume of the company and neglect the fact that most experts believe that human resources are extremely important to maintain a competitive advantage and keep a company entrepreneurial. [Beu08] Human resources policies are proven to be effective in the way they affect the performance and final results of an organization and for that motive, organizations should focus in managing their human resources the best way possible in order to extract the best of them. [YSDL96]

Creativity theory presents itself as proper heuristic to relate in a theoretical way the human resources practices and innovation because a human resources management that is focused on the creative capabilities of the collaborators of the organization is considered to be an important piece of the innovation capability of an organization and from its competitiveness. [Beu08]

A task of high degree of complexity is associated high levels of autonomy, range of competences, different identities and a proper feedback cycle. This type of task are directly connected to the training of the collaborators of the company due to the fact that the active development of the knowledge and capacities of the staff is fundamental to create and generate new product in an organization. [Beu08] There is also a strong belief that initiatives related with the training of the collaborators and the improvement of their capabilities, being exposed to a large spectrum of perspectives, ideas and continuous team work environment are strongly connected with bigger innovation performance and bigger creativity. [KMS07]

Multidisciplinary teams are also a big suggestion of a team design in order to obtain high levels of innovation and creativity. [LN04]

According to the study performed by Sjoerd Beugelsdijk, there's a set of policies that proven to have positive and negative effects in different kinds of innovation. Providing training to the collaborators of the organization has proven to have positive effects in all kinds of types of innovation except in the radical one while shifting the task performed by the staff has positives effects in productivity but not in the innovation performance. Job autonomy has a great positive effect

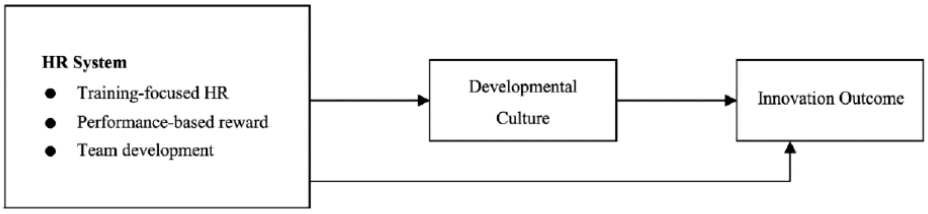

Figure 2.5: Effects of HR policies

in the development of all kinds of innovation while flexible work schedules are really important to increase the success of radical innovations but does not influence the success of incremental success. To finish the suggested policies, the study reveals that payment according to performance is a measure that has a significant and positive effect on the incremental innovation but not in the radical one and standby contracts have negative effects in the innovation capability of the company except in the radical one. Incremental innovation are easier to manage and boost since the policies that are able to increase its quality are easy to implement while radical innovations are harder to organize in the sense that is necessary to provide work autonomy to the collaborators and flexibility in the matter of their work schedules. Payment according to performance only works when the organizations pursues incremental innovations and may have a negative effect if combined with task shifting and flexible work schedules in the creating of radical innovations. Besides that, payment according to the performance should only be implemented when there is a proper way of measuring the performance of each worker. Figure 2.5 illustrate a model that shows the effects of human resources policies in the innovation performance. [Beu08]

In order to conclude, there must be a predisposition towards constant learning where team work is a must. Besides that, it is very important to give to the collaborators of the company a degree of autonomy, initiative and the freedom to follow their inclinations in technological innovation. [CLGM98]

2.6 Determinants of innovation

It is of the highest importance to state the characteristics that define an organization with high levels of innovation performance in order to obtain a reference of analysis concerning the work that is going to be developed in the study company. Determinants of innovation are characteristics of every kind that influence both positively or negatively a company's innovation program. The determinant can be internal or external.

Internal determinants refer to factors within the company that directly affect its innovation capability as the presence of creative development environment or the availability of a strategy of innovation. External determinants are factors that are not related with the company but that affect directly the innovation and are out of the control of the organization like public policies regarding taxes to start-up companies or perks for the Research and Development departments. Determinants

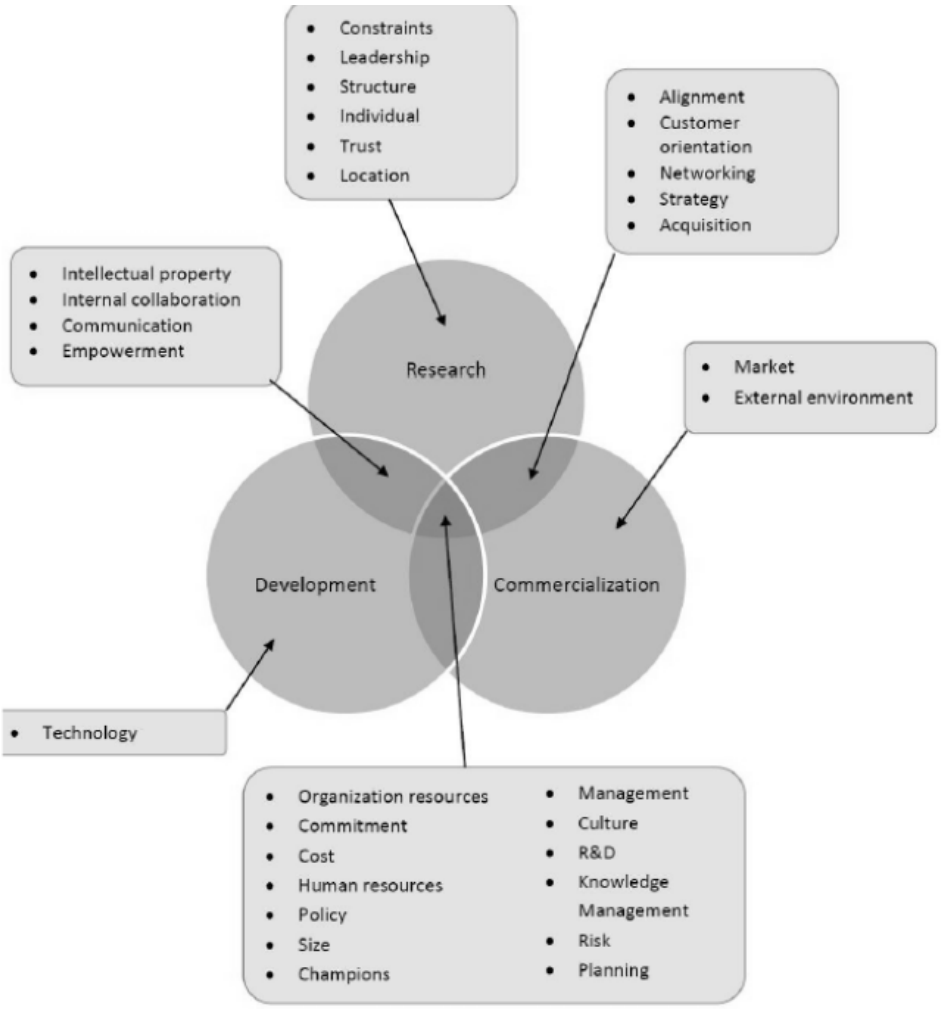

Figure 2.6: Internal determinants (Edison, Bin Ali, and Torkar 2013)

like customer-orientation, inter-functional coordination, transformational leadership, the existence of a product champion in the context of software engineering or the innovation being part of the organization's strategy, plan and culture are all examples of determinants that deeply and positively influence the performance of a company in terms of innovation. In Figure 2.6, all kinds of internal determinants are attributed to a specific phase of the innovation process according to the importance to the phase. [EBAT13]

Other authors reveal other kinds of positive internal and external determinants of innovation that all organizations must pursue in order to increase the quality of their innovation program as it is shown in Figure 2.7. [LN04]

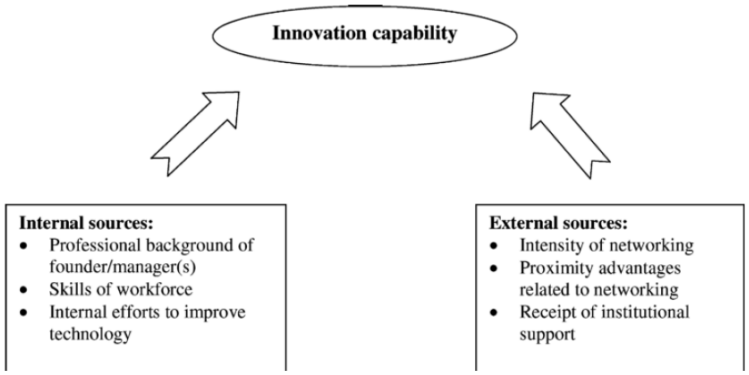

Figure 2.7: Sources of innovation capability (Lau and Ngo 2004)

2.7 Innovation metrics

2.7.1 Importance of the metrics of innovation

When an expert is faced with an explicit strategy for innovation and consequently an actual measurement program and innovation process, he strives to understand something that does not fit in the current mind-set of both executive and collaborators. It is the general belief, regardless of the roles in the company that innovation measurement is essential to give to innovation the importance of other business disciplines in the organization's life. 44 percent indicated a lack of an explicit innovation strategy and 40 percent state that there is no innovation program in their organization. It is possible to conclude that although there is a growing consensus in the academia and industry that innovation measure is extremely important, the practice of innovation measure is still lagging behind. [EBAT13]

2.7.2 Challenges in measurement of innovation in the software industry

With the conclusions above, it is important to understand what stands in the way of getting innovation measurement as an essential practice of the daily life of software companies. The lack of a consistent definition of innovation has been identified in the survey performed as one of the problems in the implementation of a measurement program in the way that the definition of innovation will affect the common understanding between all stakeholders of innovation measurement and will reduce the quality of communication between them all. Continuing this analysis, there is a common belief that there are no appropriate metrics to apply in an innovation program. However, there can be found a large number of metrics in the literature review. The reasons for this difference between the state of the art and the state of practice must be related by the lack of awareness of appropriate metrics, the lack of validation of metrics because a lot of metrics have not been subjected to validation and finally interpretation due to the fact that organizations are keen in continue to only measure the performance of innovation, as in revenue generated, instead of measuring the whole innovation process. [EBAT13]

Finally, there is also the perception there are no appropriate frameworks for innovation measurement. A set of related metrics, data collection mechanism and data uses inside a software organization with the whole purpose of achieving some goals and based on models are necessary in order to have a functional measurement program. However, there seems to be no standard framework to measure innovation. Practical Software Measurement, Balance Scorecards or GQM are all frameworks that can be used but that do not have a clear and comprehensive innovation definition, model and metrics for innovation measurement.

2.7.3 Model of measurement

With innovation being undoubtedly hard to measure, it is urgent to find a platform and framework that enables an innovation measurement program in software companies with innovation being considered to be as a whole process that needs measurement and not just a consequence of an idea of one of the collaborators of the company. Considering the key elements of innovation measurement, a model was developed and further refined after the evaluation by academics and practitioners to enable innovation measurement in a consisting way and taking into account the whole spectrum of the innovation process.

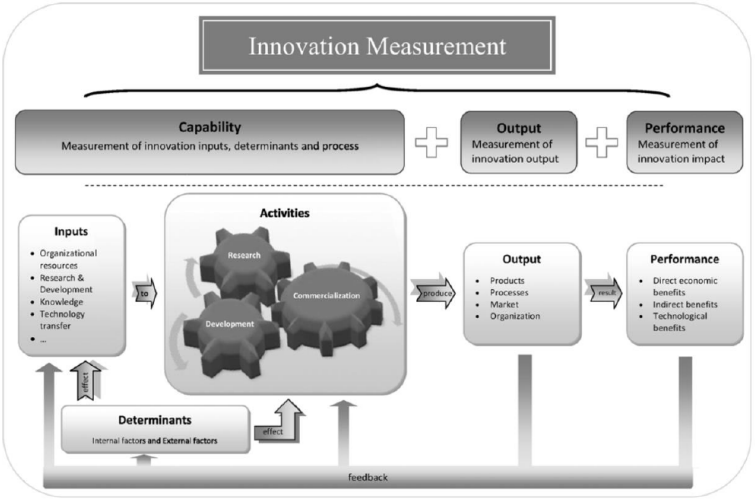

Figure 2.8: Model of measurement (Edison, Bin Ali, and Torkar 2013)

Innovation capability, innovation output and impact of innovation were identified as the three main elements of measurement. All of these dimensions can be measured quantitatively using both objective and subjective metrics which enable the process to be a smoother and more transparent. With the innovation process divided into three main phases: research phase in which the main activities are the concept generation, evaluation, feasibility and the identification of new opportunities; development phase that includes project planning, design, coding and testing; commercialization that ensures that the product is introduced to the market or the processes are implemented in the organization. Figure 9 illustrate the model of innovation measurement. [EBAT13]

2.7.4 Assessing innovative work behaviors

In order to achieve organizational success, it is extremely relevant to measure the innovative work behaviour (IWB) of individual employees. Even though being considered a matter of great importance, the measurement of IWB is still at an evolutionary stage. Jong and Hartog developed a measure of IWB with four potential dimensions: the exploration, generation, championing and implementation of ideas. IWB can be defined as an individual's behaviour that aims to achieve the initiation and introduction of new ideas, processes, products or procedures within a work role, group or organization. Creativity is considered to be a crucial component of IWB, especially in the beginning of the innovation process but IWB is intended to provide a tangible result and benefit for the organization or team. Most of the work on IWB clearly distinguishes between various dimensions that are closely related with the different phases of the innovation process. After careful consideration, the authors of the study decided to present a four-dimension model to evaluate the innovative work behaviours of an employee.

The beginning of an innovation process often has an element of chance connected with the discovery of an opportunity or some problem arising. The spark of the innovation process may be the chance to improve conditions or a necessary response to an urgent problem. The first dimension is idea exploration and its main focus is to look for ways to improve current products, services or processes or trying to think about them in alternatives ways.

The next proposed item of IWB is idea generation. The generation of ideas correlates positively with the process of finding solutions for identified problems. Combination and reorganization of information and existing concepts within the organizations appears to be the key for a successful idea generation process.

Idea championing becomes a truly important once an idea has been generated as most ideas need to be promoted to the higher ranks of the organization in order to be sponsored for future implementation. Furthermore, it is important to check if the implementation of an idea will bring positive outcomes to the organization by comparing the idea's benefits with the cost of its development and implementation.

When an idea has the sponsorship of the organization, it is necessary to proceed to its implementation. Idea implementation is the final dimension of the model of measurement proposed by Jong and Hartog that takes into account that a considerable effort and a result-oriented attitude are needed to make ideas happen. Idea implementation also encapsulates making innovations part of regular work processes and behaviours in the ordinary day of the organization or team.

The IWB assessment was subject of a variety of tests to examine the factor structure of the measure and its reliability proving to be successful in both accounts. The questionnaire has a 2 types of measurement in which the supervisor rates the innovative work behaviours of the employee and the employee rates the participative leadership, the external work contacts and the innovative output in its ordinary job. In this work, some items of the questionnaire were dropped as they were not applicable to the software teams and the supervisor rating of the innovative work

behaviours were substituted by and evaluation of the employee's contribute to the innovation process of the organization. [DJDH10]

2.8 Culture of innovation

Everything that is a part of an organization or company has a tremendous impact in all kinds of performance and in the final quality of its products or services. All collaborators must have the chance to be entrepreneurial and to contribute to the success of the the company. In order to be innovative and to achieve high levels of qualiity in the innovation process, Employees of big companies tend to pursue new ideas but find it hard to get support from the administration to develop their ideas and turn them into something with market value. According to a survey performed by Accenture, nearly half of the interviewees say that getting support from management is critical but only one in five believes that their company actually delivers that support as it can be seen in Figure 2.9. [Acc13]

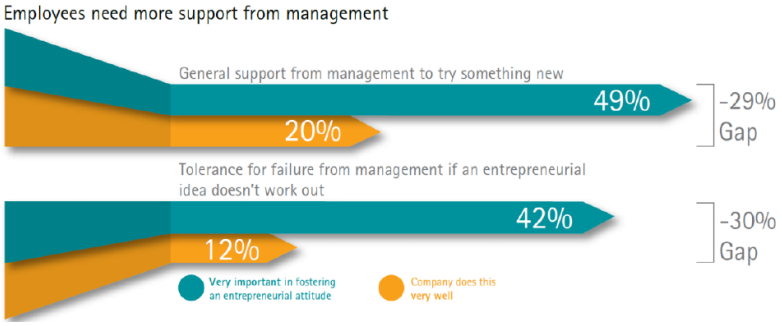

Figure 2.9: Support given to employees by the company (Accenture 2013)

Corporate support for encouraging entrepreneurialism varies greatly but still there are many companies that help their employees in the difficult task of developing innovative ideas. David Lawee, Google's vice president for corporate development, was quoted in a New York Times article saying that Google entrepreneurs "have to think bigger" and that the company provides the necessary resources to back up that philosophy which includes infrastructures, money, time and people. With this mind-set, the Innovation time-off program was born better known as the '20%Time Off' with proven results like Gmail and AdSense from Google and the famous Post-It from 3M. [Bal12]

Having an orientation of the company towards a culture of centralized knowledge, allows higher levels of innovation results with the influence of knowledge exploration practices. With this statement, it is easy to deduce that a corporate environment that allows the exchange of knowledge and information in an easy, transparent and efficient way is extremely important to increase the quality of the innovation process. [DG11]

The innovation program to be successful needs to be supported in a company that it is designed to be innovative and successful. As stated by Charles O'Reilly and Michael Tushman in

their study, functional designs that integrate project teams into the existing organizational and management structure, unsupported team that are set up outside the established organization and management hierarchy or cross- functional teams that operate within the established organization but outside the existing management hierarchy are less suitable to reach the company's innovations goals. Ambidextrous organizations (in Figure 2.10) that establish project teams that are structurally independent units with its own processes, cultures but that are integrated into the existing management hierarchy are more likely to obtain success in the innovation performance. [Tus04]

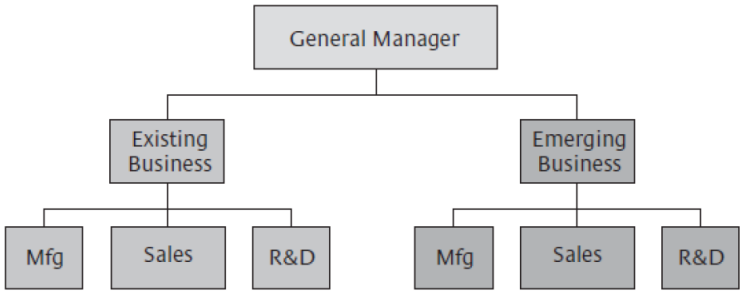

Figure 2.10: Ambidextrous organizations (Tushman 2004)

Besides the effect of the impact of the organizational chart in the innovation capability, there is a need for the innovation to rise on the top of true pillars and cornerstones. Google's culture nurturing that allows for innovation is one of the key to success. Having a mission that matters and that guides and influences all decisions is fundamental, thinking big but starting small allowing ideas to mature and develop, striving for continual innovation instead of instant perfection and looking for ideas everywhere are pillars that Google use to drive and guide their innovation process. Allowing engineers during their time-off to try what sometimes seems to be impossible is one of the pillars of innovation that guides Google's innovation process. A driverless car is one of the example where intuition when fuelled by insights turns out to be something possible and tangible. Becoming an open platform in some products and permitting that outside collaborators can give their contribute and not being afraid to fail as long as people learn from their mistakes are the final cornerstones of Google's innovation process.

2.9 Physical environment and innovation

Today's business is characterized as a fierce competition between players that tend to expand their market share through creativity and innovation. The physical workplace can be a stimulant of creativity and innovation and for that reason it has to be looked upon with great care by managers. Business differentiates from each other by their capacity of delivering innovation on a regular basis. [DL02] As office work become less administrative and less time and place dependent, work is becoming more complex, creative and knowledge intensive. [HKPL04]. Literature also refers that office space can contribute in a positive manner to the company's performance and it also

suggests that the physical work environment have a positive effect on the creativity of an organization [NN00] [VdV04]

2.9.1 Creativity and the physical workplace

A spark of creativity can happen everywhere and any time. Taking that into account, technology is now able to provide to the creative office workers the necessary tools to do their job wherever one goes but it is still extremely important for creative and knowledge intensive workers to have a common space in the office where they meet colleagues, learn, have small talks with the managers or even catch up with all the new gossip that goes around the organization.

An organization that has a real state that serves a statement and is used as marketing vehicle, a workplace that has an experimental component by stimulating visually the creative works and that is supportive of the creative and collaborative work and the sense of sharing space with all the staff are practical features that can be encountered in workspaces designed to boost creativity. [Flo02]

Amabile's work identified several a priori conditions that can represent stimuli to creativity within organizations [ACC+96]:

- Freedom - when someone has control of his/her own work and ideas;
- Challenge - a sense of having to work hard on challenging tasks and important projects;
- Resources - access to the fitting resources, including people, materials, facilities, information and knowledge;
- Supervisor - a leader or manager who sets objectives and acts as an intelligent, enthusiastic role model;
- Coworker - an environment where communications between peers are constructive and made with trust and openness;
- Recognition - feedback leads to recognitions and reward;
- Unity and cooperation - a cooperative and collaborative atmosphere where ideas about a shared vision flow naturally;
- Creativity supports - creativity is encouraged and mechanisms exist to foster creative expression;

Taking into account these conditions, the following dimensions of physical settings related with creativity were presented by McCoy in his paper about the role of physical environment in fostering creativity:

- Nature - nature has been a preponderant element in restorative environments and theories about the restorative qualities of nature refer to creativity as a process that is improved by contact with natural elements;

- Challenge - tasks considered to be creative are engaging when they are challenging. A complex and intricate environment, that offers a promise of more information if explored, is considered to have high marks in challenge and is consistent with the creative personality characteristics described by Baron and is also considered to be a contributor to the enhancement of creativity; [BH81]

- Freedom - the freedom to choose and explore is characteristic of an environment that supports creativity. Personal autonomy and flexibility are necessary to enhance rebelliousness, mood fluctuation and unconventional thought processes that are considered to be prerequisites to creativity and innovation;

- Support - just as the social environment, the physical environment has to reflect the support that organization provides to innovation by offering a non-judgmental acceptance and understanding of any kind of preference regarding the physical environment; [ME02]

2.9.2 Physical environment and elements to foster creativity and innovation

McCoy's paper had the intent of identifying physical elements of interior environments that could predict the potential creativity enhancement of a specific setting. Working from an initial set of dimensions to analyse and correlate with innovation and creativity, McCoy reached the following conclusions:

- Spatial form - considering the correlations obtained in the study, there is no association between size or rectilinearity of the shapes present in the physical environment with the creativity potential;

- Light - neither quantity nor quality of light was significantly related with creative potential;

- Internal organization of objects - furniture and visual detail were both considered to be highly correlated with creativity potential. Furniture that allows and promotes social interaction implies a high degree of creativity potential and high levels of visual detail significantly enhanced the perceived creativity potential of a setting;

- Characteristics of bounding surfaces - manufactured or composite materials showed a strong negative correlation with creativity potential while natural elements had a positive correlation implying that enhanced creative performance is perceived in a room in which natural material can be found;

- Color - cool colors had a significant negative correlation with creativity potential and cannot be perceived as being conducive to creative and innovative behaviors;

- Glass - the presence of glass appeared to improve the ratings of creativity potential;

- Transparency - as it was expected, view and natural view correlated strongly with creativity potential;

- Texture - the amount of texture of wood grain was found to be associated positively with creativity potential. [ME02]

The effect of five characteristics on creativity potential can be seen in Figure 2.11

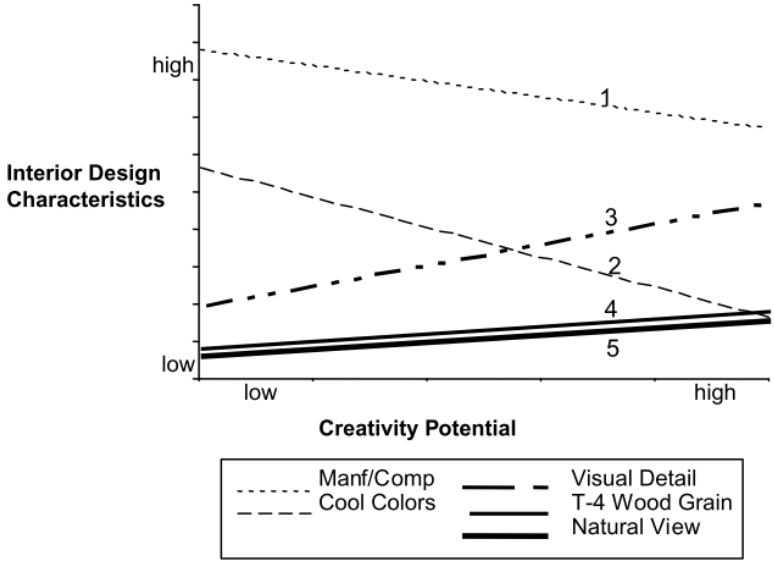

Figure 2.11: Effect of five characteristics on creativity potential(McCoy and Evans 2002)

Environments with high perceived creativity potential most frequently tend to be highly complex both spatially and ornamentally with extended views and natural materials present. Natural views are associated with the higher levels of creativity but even an obscured view contributed to more creativity and innovation than having no view at all. A natural view from a window is a method of achieving exposure to a natural environment while remaining present in the interior physical environment. The feeling of reducing mental fatigue, restoring cognitive capacity and freedom is expected to be conducive of creative and innovative performance. An unexpected finding in McCoy's paper was the importance of the type of finish and visible construction materials. An incorporated and obviously not exclusive use of natural materials is correlated positively with environments prone to boost creative potential. Besides all these dimensions, a sociopetal furniture arrangement that allows constant interaction between the team members showed a strong correlation with the creativity potential. [ME02]

A well designed office is a strategic HR practice to create a desired organizational culture of creativity and innovation. Literature was developed in order to attest and prove that certain elements of the physical work environment are possibly related to creativity and to innovative behaviours. Ridoutt et al. stated that the use of wood for the organization headquarters' furniture is a common practice of companies considered to be innovative and energetic. [RBK02]

In 2004, Shibata and Suzuki performed a study to investigate the effects of an indoor plant on the creative task performance and mood. Three different rooms were used as independent variables: a room with a plant, a room with a magazine rack with magazines placed in front

of the participants and a room with neither of these objects. With that study, the authors were able to show that creative task performance (especially in female participants) is enhanced by the presence of a plant. This improvement may not only be connected to the change of mood of the participant or the availability of a source of innovation (the magazines). There is the possibility that the participant's task performance was also affected by the degree of compatibility between the task and the environment. [SS04] Another study about the effect of physical elements on creativity potential indicated that the presence of plants were highly correlated with high creativity potential. [CDA08]

Ceylan, Dul et al. presented a different perspective from the McCoy's paper relating to the colors related with high creativity environments. It showed that cool colours are related to environments prone to deliver creative outcomes. This difference between the studies may be related with the non-comparable studies population, environments and cultural differences. Nancy Stone's paper about the impact of colours on different tasks concerning their difficulty has to be taken into account as it shows that calming colours like blue correlate positively with creative and innovative tasks. [Sto03] [CDA08]

Stokols et al. demonstated in their 2002 work that privacy, as in the possibility of being secluded from the presence or view of others, is also slightly correlated with innovative and creative processes as it assures that the creators can develop their idea without any negative initial public judgement. [SCZ02]

Hygge and Knez stated that the indoor physical climate can have a low impact in the creative processes as they could only prove that working memory increased its speed in a noisy environment but at the expense of increasing errors. [HK01]

Positive sounds (calm music, silence, absence of noise) are directly correlated with the creative process by improving the mood of the employees of the environment [dFdA96]

A famous consulting agency that works directly with physical environments and innovation suggests that the space has to be flexible in order to support spontaneity, switches to different work modes and the dynamic flow of information. Semi-permanent walls, movable partitions, a flexible hub for large and small group activities, user configurability with mobile furniture and enclosed spaces that provide privacy are some of the suggestions to make the space more flexible. Creating something new is fundamental to any company and inspiration is an important factor of the process. Abundant natural light and views, providing settings that are casual, informal and comfortable and allow artwork and meaningful objects throughout the space are usual tips of how to make the space inspiring. A space that is collaborative, that serves as a hard-working tool, that reflects the brand and a culture and that is social is considered to be a space designed for innovation. [Fut10]

2.9.3 Physical environment assessment for innovation and creativity

The Creativity Development Quick Scan (CDQS) is a checklist that has to be filled out by the employee in which he/she rates the extent to which each element of the framework's work environment is present. It's used a 7-point scale to rate the work environment and the final overall

score is obtained by summing the separate scores for the 21 work environment elements. With that being said, it is presumed that each element is equally important and that the overall support from the work environment to creativity and innovation consists of parts that can add up. A low overall score indicates that the employee perceives little support from his/her work environment, while a high score indicates much support.

Number	Element	Description
1	Challenging job	The complexity of the job, and how demanding the job is.
2	Teamwork	Working in a group of people towards a common goal, by having interactions with each other.
3	Task rotation	A schedule with a set of different tasks to be performed simultaneously.
4	Autonomy in job	Decision latitude in the job, for example with respect to deciding about the order of work tasks.
5	Coaching supervisor	A supervisor who supports and encourages employees, builds mutual trust and commitment, and provides positive feedback.
6	Time for thinking	The availability of time for idea generation without the time pressure in everyday work.
7	Creative goals	The situation that the employee must produce new ideas according to goals, and with the expectation of evaluation.
8	Recognition of creative ideas	The recognition (e.g. praise, awards) of new ideas.
9	Incentives for creative results	Possibility of rewards (e.g. pay raises, profit sharing, bonuses, promotions) after reaching creative results.
10	Furniture	Furniture (e.g. chairs, tables, cupboards) that are placed in the workplace.
11	Indoor plants/flowers	Natural plants or flowers that are placed in the workplace.
12	Calming colors	Colors that provide a relaxing experience (e.g. green, blue, or blue violet).
13	Inspiring colors	Colors that provide a stimulating experience (e.g. yellow, orange, pink, red, or red violet).
14	Privacy	The possibility of being secluded from the presence or view of others.
15	Window view to nature	Having visual access from the work environment to the outer natural environment (e.g. trees, plants).
16	Any window view	Having visual access from work environment to any outer environment.
17	Quantity of light	The amount of light in the work environment.
18	Daylight	The light coming from the sun into the work environment.
19	Indoor (physical) climate	The temperature, velocity, humidity and composition of the air in the work environment.
20	Sound (positive sound)	Positive sounds (e.g. music, silence, absence of noise).
21	Smell (positive smell)	Positive odors (e.g. fresh air, absence of bad smell).

Figure 2.12: Elements of evaluation in CDSQ (Dul and Ceylan 2011)

CDSQ measures not only the extent to which creative elements of the work environment are present but also asks the employee to rate for each element how important it is for supporting his/her creativity and capability to innovate using a 7-point scale that ranges from “not important at all” to “very important”. The elements that are evaluated can be seen in Figure 2.12. With these two different scores, it’s possible to evaluate if the environment fits the person’s needs when a presence score is larger than the importance score whereas a “misfit” happens when the presence score is smaller than the importance score revealing useful information for setting priorities for improvements. [DC11]

2.10 Team climate and its impact on the organization's innovation capability

A lot of research about team work and how team work is or is not a critical factor in an eventual project's success has been made throughout the last decades. The concept of team work carries with it a set of values that encourages listening and responding to others in a constructive and positive manner, giving others the benefit of the doubt and providing support while recognizing that the success of the team mates helps the team to achieve a good standard of performance and by that it helps him/herself. Most of these studies are related with climate at work group and team level, with the specific characteristics of teams over time which indicates clearly that teams go through set phases or about the relationships between team members leading to a discussion about the importance of team cohesiveness in the team's success. However, the use of teams does not always result in a successful project or work. Reaching a high performance standard within a team is a complex and intriguing achievement. That performance depends not only on the competence of the team in managing and executing its work but also on the organizational context and climate that is provided by the higher management ranks and by the company as a whole itself. [GD96] [Lan00]

One of the most famous trends in the management's and business' world is the self-managing, autonomous or empowered teams. Research suggests that their use promotes more satisfied employees, lower absenteeism and lower turnover. More importantly, research claims that self-managing teams are a prerequisite for the success of innovative projects. Incorporating autonomy in designs made by teams is an important process in the majority of the most influential organizations. Team-level autonomy, rather than team-leader or team-member autonomy, corresponds to the high level of complexity and uncertainty inherent in projects that are projected to be innovative, creating interdependencies among team members that obviously requires intensive collaboration between everyone in the team. With that said, team leaders must be made aware that they should provide teams with information instead of instructions to achieve success in an innovative project. [TN86] [HP06].

2.10.1 Tuckman's Stages of Team Development

In 1965, a model of team development was proposed that was based on a four-stage model. The sequence "form, storm, norm and perform" became world-known and quickly the model was considered to be a standard for the team development stages. A subsequent review was made in 1977 that concluded that the literature generally supported the original idea and that there was only the need to add a fifth stage called adjourn. [TJ77]

The 5 phases of the Tuckman model are the following:

1. **Forming** happens when there is the initial concern with orientation that it is accomplished mainly using testing to identify the boundaries of both interpersonal and task behaviours; this phase is also coincident with the establishment of dependency relationships with the

leaders, other group members or pre-existing standards. With that said, it is possible to say that forming is the process of orientation-testing-dependence;

2. **Storming** is the second phase of the Tuckman process and it is characterized by conflicts and polarization around interpersonal issues; team members averse to conflict may be affected by this stage in the process and traditional behaviours serve as resistance to group and tasks normality;

3. **Norming** happens when the resistance is overcome, cohesiveness and in-group feeling develops, new roles are adopted and new standards evolve; in this stage the team members are ready to express intimate and personal opinions;

4. **Performing** is the final phase of the original model designed by Tuckman in which the interpersonal structure becomes the tool of task activities; roles become flexible and functional while the group energy is channelled into the task; task performance is now supportive of task performance and structural issues have been resolved;

5. **Adjourning** was an addition made to the original model and involves completing the task and breaking up the team. [Tuc65]

Today, the model is considered to be idealized and has face validity as a general sequence. However, empirical studies on specific teams reveal different problems that cannot be explained using a simple stage sequence like the one that is presented in the initial study. A great numbers of teams may never attain a norm of performance or may regress to an earlier stage of development as a problem occurs. When it comes to teams attempting to develop innovative products, two critical questions need to be answered:

1. "When a team fails to achieve expected performance, what mechanisms are at play?"

2. "What mechanisms lead to outstanding performance?"

Neither the Tuckman nor the Tuckman-Jensen models provide answers to these two questions. However, it is necessary to be aware that these two models have no way to explain how to achieve outstanding creative performance. Teams had to deal with barriers of some sort and taking that into account, Rickards and Moger reworked the classical model to illustrate those barriers designing a two-barrier model to creative performance. The first barrier represents the personal issues between the team members that need to be overcome prior to norm formation. That barrier is considered to be weak since it is only a temporary obstruction which the majority of teams overcome. The second barrier represents the forces that are overcome when a team breaks out of the conventional expectations within specific social context like a corporate culture. Team that fail to pass the first barrier show a dysfunctional behaviour and need to be looked out for. The teams that are able to overcome the second barrier, the strong one, display an exceptional creative performance and can be looked upon as exceptional assets that can bring innovation to the organization's products, services and processes. [RM00]

2.10.2 Personality/behavioural tests and the importance in building a team

An important topic for this paper is the research made on teamwork related with the development of tests to identify personality characteristics in order to prove that a good team is more than a set of people with different technical skills, good teams are a result of a certain blend of personalities. In this matter, there are a lot of different studies as the Myers-Briggs Type Indicator, the Big Five, the Packtypes or the Belbin team role theory.

Each person has its own individual and personal characteristics that are not easily modified even if behavioural training is used. Today's scientific literature already reflects that abundance of personality traits theory especially in the field of clinical psychology. A major obstruction for the development of this kind of theory is the lack of consensus about what kind of test or personality scale should be used which turns the process of comparing methodologies a hard job. [KW97]

Although there is not a high degree of consensus in this field of studies, a lot of researchers suggest that the evaluation of the personality traits of each team member can be considered as an important prediction tool for the future success of the team. On the other hand, a lot of researchers show disbelief in this approach claiming that the studies made about personality and how a certain kind of personality affects a wide array of situations are a solid argument against this kind of study.

Even by taking all this into account, it is extremely important to realize that the usage of this knowledge can represent an opportunity to maximize the team's efficiency and productivity by assuring that team's personality profile, which is the sum of the personality profiles of all the team members, is adequate to the demands of the work that has to be done. [KW97]

Before proceeding to the explanation of the personality analysis methodology used in this work, it is important to have a brief enlightenment about other possible methodologies that can be used.

2.10.3 Big Five

Goldberg's Big Five personality factors are widely used to classify the personality of a person. This model uses the NEO-PI-R test to assess the personality of the person. The factors that exist in this model are the following:

- Neuroticism that is considered to be the tendency to experience negative emotions like depression, hostility, anger or anxiety. Can also be referred as emotional instability. This factor can be seen in individuals that tend to make more errors, worry too much about their anxieties and fears and show more stress symptoms;

- Extraversion is related with a variety of behaviours and with the ability to create energy from external means or sources. This personality trait is highly correlated with the external world and individuals with this trait tend to enthusiastic and action-oriented but are also more sensible to monotony and under perform in vigilance tasks;

- Conscientiousness is the propensity to show self-discipline, obedience and desire to perform and reach the proposed objectives. Besides that individuals with this trait always like to be

involved in the decision-making process, follow rules and standard procedures and are less vulnerable to cognitive let-downs;

- Openness is the predisposition to appreciate new intellectual experiences and ideas. Persons with this trait are considered to be highly imaginative, creative, curious and open-minded. They also show that they enjoy the learning process but are less reliable in critical safety tasks as they are susceptible to break rules with their improvisation and experimentation;
- Agreeableness is the tendency to be compassionate and cooperative. Individuals with this trait are considered to be tolerant, discrete, respectful, modest and trust worthy. [SLO+07]

Software engineering is an activity that demands cognitive ability due to being highly technical and complex. Its success is dependent of factors like abstract way of thinking, analytical mind-set and abstraction. Consequently, it is important to have another factor to evaluate that trait when using Big Five in the context of Software Engineering. That factor is called Cognitive Ability and is the trait that ensures the evaluation of the factors mentioned above. [SLO+07]

Big Five's critics claim that this model of analysing personalities has not been studied enough by the academic world and that the five factors are not orthogonally distant from the others which may lead to some errors of judgment. In addition, the Big Five test is exclusively personal and self-perception is not always a right path to follow in matters of personality evaluation. [Ben95]

2.10.4 Myers-Briggs Type Indicator

Carl Jung believed that people relate with each other through sharing experiences and by adopting different attitudes towards life in order to fulfil personal beliefs. Jung distinguished four main functions: the thought, the feeling, the sensation and intuition. Based on those functions, he claims that those functions are associated with two types of attitude: introversion and extraversion.

Based in Jung's theory, the Myers-Briggs Type Indicator is a pretty well-known and regarded personality test. The evaluation tool is composed of ninety four questions with four bipolar scales. In the end, the person is evaluated in sixteen different types of personality based in the ranks obtained in each bipolar scale. The bipolar scales are the following:

- Regarding attitudes: Extraversions vs Introversion;
- Regarding how the received information is treated: Sensing vs Intuition;
- Regarding how people decide: Thinking vs Feeling;
- Regarding how people live: Judgement vs Perception.

The MBTI is not completely trustable as it relies in a self-perception questionnaire that delivers results that can be modified in order to try to obtain a certain type of result. In addition to that, the MBTI test uses statistical analysis to place a person into a category which means that two different persons can be placed in the same category even if they have a relatively high difference in the score for that category. [CA10]

2.10.5 Packtypes

This is a recent theory created in 2008 by Will Murray. A Packtype is an approach developed to enhance and modify the emotional intelligence. Each Packtype represents a set of different preferences and characteristics. Instead of the normal questionnaires, the person is asked to select the most relevant 12 cards from a deck of 64. In each card, there is a word that can be related with several types of environments since the personal, cultural to the professional one. The assessment of the cards to be picked should be a fast process, giving place to the person's instinct to decide whether to keep or discard a card. Each Packtype is more suitable for some actions/tasks leading to a high degree of importance attributed to the balance of the set of Packtypes of a team.

The Packtypes are the following:

- Hound is a person that is prone to tasks related with creativity, challenges, risk taking and idea exploration;
- Pointer is someone related with analytical behaviour and is someone that deals well with facts and measurements;
- Guard Dog is a leader by nature, someone who likes the decision making process and management;
- Coach Dog is a team player, is someone who cares deeply about the others and if their interactions are successful or not;
- Mastiff is a person passionate about communication, idea sharing and networking;
- Retriever is a process improvement seeker team member;
- Sheepdog is someone focused in the process of organizing and planning teams and resources to obtain future success;
- Terrier is considered to be the implementer and is someone that is highly concentrated in delivering products in time and with quality.

There are still not relevant studies that relate the Packtypes theory and Software Engineering. [Mur10]

2.10.6 Belbin Team Role Theory

R. Meredith Belbin published in 1981 a book called Management Teams in which he describes personality types from the perspective of interactions between the different team roles that are represented by the members of a team. Those role functions are explained as a range of behaviours of a person based on both internal and external influence. Belbin's approach to team building in the field of Software Engineering has been endorsed by several works that try to prove how feasible that connection can be made. [Sch01]

Forming a high-performance team while freely choosing the team members is a hard and demanding task. That problem concerned Belbin and lead him to a quest throughout the years in order to find a proper solution to it. Figuring why not create a team entirely composed of clever analytical people that are ready to deal with problems and decisions is still, today, a matter of study. A key finding of Belbin studies was that Apollo Teams (teams that are composed by persons that had the highest scores in the cognitive ability tests) are not the ones that show higher standards of performance. The Apollo team members usually spend a lot of their time engaged in abortive debate, trying to persuade the other members of the team to adopt their own particular idea. With that mind-set, is hard to be converted or hard to convert someone. Apollo teams are difficult to manage, prone to destructive debate and struggle with the decision-making process. Members usually act in lines that favour them personally without thinking on other team members.

Concluding, the Apollo syndrome refers to a phenomenon found if groups whose members are chosen for their critical thinking abilities and where destructive tendencies tend to result in an underachievement by the team. People with high analytical abilities may not be creative and the other way around.

With that said, Belbin's studies offer a new way of looking to team in order to get a proper balance of team roles to achieve high standards of productivity and innovation.

Belbin was responsible for a long study about team roles and the impact of the different personalities on the teams. Allocating persons to a specific team was mainly theoretical. It was considered to be more than just a theoretical exercise. Particular personality characteristics lead people to be drawn towards particular occupations and if that occupation is related with team management, a concern about the congregation of different types of persons is truly appreciated.

Recruitment's tendency of the today's business world is based on a principle called elective homogeneity. This principle refers to some group of related factors that cause companies to recruit a particular type of person. The natural tendency of managers recruiting in their own image is a crucial aspect of this principle. Intellectual and creative managers usually see their kind as an essential part of a successful effective operation of the team while calm and serene managers are likely to see calmness and serenity as a vital part of a team member. There is another factor associated to that tendency. Any employing body tends to favour a particular type of personality due to its culture. Some forms of behaviour attract acceptance and prestige in one organization but may have a repellent effect in other organization. Belbin's goal was to prove that there is room in an organization for all types of people and that even those with unusual idiosyncrasies will find their role somewhere within the organization. The only thing that was needed was to show competency for the area that the person was recruited. [Bel10]

The first experiment was dedicated to see the potential success of "pure" teams as in teams composed with persons with the same scores in the well-researched scales of introversion/extroversion and anxiety/stability. The four broad types that were developed and the well-known executive occupations that are associated to them are the following:

- Stable extroverts are known to fulfil themselves and outperform in tasks related to liaison

work and where cooperation is required from others. Sales, Marketing and Personnel Management are the areas considered to be suited for this type;

- Anxious extroverts are often found where people need to work at a high pace and apply pressure on others in order to succeed. Sales managers, team managers and editors are the ones that usually show this kind of behaviour;
- Stable introverts seem to have good performance in work where good relationships with a small number of people need to be maintained over a period of time. Administrators, solicitors and corporate planners are jobs related with this kind of personality;
- Anxious introverts distinguish themselves in jobs that call for self-direction and self-sustaining persistence. Research scientists and specialists committed to long term assignments are the predominant group of jobs associated to this type of personality. [Bel10]

Belbin discovered that putting together a team composed entirely of one of the four types of personality mentioned above brought out extremes of behaviour and effect. In general, teams that can be described as being extroverted teams usually have a higher rate of success than purely introvert ones. [Bel10]

After the experiments based on pure teams, Belbin focused on discovering how to identify a team member common to successful teams but that had different final objectives and so it began to cluster the individuals based on their behaviours, achieving the Belbin Team Role Theory as it is known today.

A team role is defined by Belbin as a tendency to behave, contribute and interact with others in a particular way. Team roles describe patterns that characterize the behaviour of a person regarding its team. With this, Belbin's work has a high value to a team and a team member as it can try to pursue a certain type of behaviour that suits best to the team's needs.

Belbin's original work defined 8 team roles that were clustered into 3 different groups:

- Team roles oriented to people: Co-ordinator, Resource Investigator and Team Worker
- Team roles oriented to action: Shaper, Implementer and Completer Finisher
- Team roles oriented to thinking: Plant and Monitor Evaluator.

The original model was actualized a few years after and included a new team role oriented to thinking, the Specialist. This work is based in the original work by Belbin and so it will not take into account that team role. It is now presented the team roles in a more detailed way with its positive characteristics and flaws: [Bel10]

2.10.6.1 Co-ordinator

Previously called Chairman, the Co-ordinator (CO) is a team role responsible for the leadership role within the team. People who usually fit in this team role are calm, controlled and self-confident. They have excellent skills to deal with team members and don't have any problem

in finding a way to motivate them and extract the best of each team member. At the same time, a Co-ordinator is someone who is goal-oriented.

The technical knowledge is not better than the rest of the team roles of the team but they shine because they are able to involve everyone and make everyone in the team feel that they are useful and important to achieve the predicted outcomes.

They are trust-worthy and comprehensive while they orient their actions by values that are related with the team as a whole and how the team can perform well by leveraging the talent of each team member. They have a great talent in solving discussions and arguments however they spend too much time trying to please everyone which may lead to having too many people trusting too much on them and eventually, overload them with tasks.

2.10.6.2 Team worker

The Team Worker (TW) profile characterizes the individuals that are worried about the relationships between the team members. They have the capacity to hear and deal with all kinds of personalities and are able to apply pressure and influence the team members to make everyone to put the team's interests above the individual ones. A Team Worker is someone who is outgoing and always pays attention to how a task should be made and to the planning and grooming of a potential idea.

Regarding its flaws, the Team Worker is not capable of controlling the execution of a plan and they are not mentally strong enough to stand for their way of thinking in a decision making process.

2.10.6.3 Resource Investigator

The Resource Investigator (RI) is a profile oriented to people that look for fragments of ideas out of the team's environments and develops them into something tangible. A person that is a Resource Investigator is considered to be communicative, outgoing and that has excellent speaking and social skills. Besides that, is always aware of everything that is happening around them and always strives to find opportunities everywhere. He has natural skills to recruit/spot talent and loves arguments and negotiations.

One of his biggest strengths is the attraction for challenges and his biggest flaws are the lack of effort shown after the initial attraction for an idea disappears. Always wanting to do something different from the last work can be seen as a negative characteristic.

2.10.6.4 Shaper

Shaper (SH) is another Belbin team role profile associated with the leadership task. Unlike the Co-ordinators, the Shapers are considered to be outgoing persons and truly dynamic. The leadership provided by the Shaper are considered to be different from the one provided by the Co-ordinator because is based on defying inertia, compliance, inefficiency or disappointments within the team.

The Shaper is, in many ways, the opposite of the Co-ordinator. They defy, argue and disagree in order to evolve somehow in the task in which they are inserted. Besides that, turning inpatient or easily frustrated are characteristics that are easily spotted in Shapers because they are considered to be opportunists, highly sociable and always ready to react to disappointments or conflicts.

Finally, it can be stated that while the Co-ordinator leads by managing and controlling the resources available, the Shaper is someone who leads by instigating the necessary actions to succeed.

2.10.6.5 Plant

The Plant (PL) is the person responsible for the idea generation inside the team. Usually, is the most ingenious and creative member of the team. At the same time, the Plant is considered to be extremely intelligent, independent and visionary while showing a strong technical background.

A Plant is someone who is completely oriented to the future and that demonstrates true care for innovation by ignoring the obvious and consistently choosing the less conventional path. With that said, a common flaw of the Plants is that they ignore incidentals and are usually too preoccupied to communicate effectively. In addition to that, they are easily distracted from the team tasks and always look to work alone as they prefer an introvert and concentration-oriented behaviour.

As a final point, the Plant is someone who is highly creative and likes to deliver innovative products or features. However, is someone that sometimes has a hard time expressing their ideas and does not always play their part in the team.

2.10.6.6 Implementer

The Implementer (IMP) is the team role in Belbin's Team Role Theory allocated to the person focused in implementation and execution of the team's tasks. They provide stability to the team as they are the persons responsible by implementing and turning into reality the plans and concepts defined by team. They are really organized, hard workers, self-disciplined, conservatives and show a high practical sense. The global result of the team is more important than their personal interests even if the tasks that they are performing are not appealing or interesting. The Implementers have the ability to identify the needs of the team and to assume the responsibilities that the other team members avoid. However, they are not flexible and are not able to deal properly with innovative ideas and processes and with environmental and situational changes.

2.10.6.7 Monitor Evaluator

The Monitor Evaluator (ME) is a team role profile that has the goal to provide stability and equilibrium to the team. He/she tends to be prudent and does not develop an emotional relationship with job made. At the same time, he/she does not develop and generate ideas but they appreciate to analyse all the issues with care by having the time to judge facts properly. They are considered to be the right people to make difficult and crucial decisions.

They are the ones who try to prevent the team from making conceptual crucial errors and show flaws in the plans made by the team before any commitment has been made. They have a great ability to detect potential errors but are not so proficient in getting solutions for that problem. Finally, they are sometimes responsible for slowing the progress of the team because they want to be sure that all potential errors are detected.

2.10.6.8 Completer Finisher

The Completer Finisher has a role of equilibrium as the Monitor Evaluator. In this group, there are the persons that have the ability to finish unfinished tasks as they are incredibly perfectionists and always try to avoid errors and omissions in their team. Delivering on time, on scope and on budget are worries that constantly haunt a Completer Finisher.

A lot of team roles in Belbin's Team Role Theory have the drive and will to begin a project or task with success but only the Completer Finisher has the determination to finish those with quality.

Figure 2.13 describes all the Belbin Team Roles. [HTS99]

Name	Symbol	Behavioural Description	Typical features	Positive qualities	Allowable weaknesses
Co-ordinator	CH	Guiding leader that knows the better side of the team members	Controlled, self-confident and calm	Treating and welcoming all contributors without prejudice. Objectiveness	Ordinary in terms of intellect and creativity
Shaper	SH	Demanding and coercing leader that pushes for members to excel	Restless and excitable	Drive and readiness to challenge inertia and complacency	Prone to provoke and irritate
Plant	PL	Innovator and problem solver, the who generates ideas	Unconventional and individualistic	Genius, imagination and knowledge	Up in the clouds and distracted
Resource Investigator	RI	Contact person for resources external to team, brings resources into the team	Extroverted and communicative	Capacity for contacting people.	Loses interest once the initial fascination has passed
Monitor Evaluator	ME	Analyses and evaluates proposed solutions	Prudent an unemotional	Judgement and discretion	Is not able to motivate others
Implementer	IMP	Implements according to what was planned	Conservative and predictable	Self-discipline and hard-working	Not flexible and does not respond to unproven ideas
Team Worker	TW	Facilitates team functions and acts as mediator in the team	Socially oriented and sensitive	Promotes team spirit	Indecisiveness at moments of crisis
Completer Finisher	CF	Focuses on details and meeting deadlines	Anxious, conscientious and orderly	Perfectionism	Tendency to worry about small things

Figure 2.13: Belbin Team Roles (Henry and Todd Stevens 1999)

	Suitable	Unsuitable
Eligible	Ideal Fit (Short Stayers)	Poor Fit (Problems)
Barely Eligible	Surprise Fit (Long Stayers)	Total Misfit (Leavers)

Table 2.1: Recruitment table

2.10.6.9 Criteria of belonging to a team

Regarding recruitment, Belbin stated that skills and knowledge can be acquired by training and experience but they are insufficient by themselves to ensure suitability for a job. Stress and other problems tend to arise when the demands of a particular form of work conflict with the natural behavior of a team member. In order to succeed, the member must be evaluated regarding its eligibility and suitability. [Bel07]

Eligibility can be seen as the minimum requirements for the jobs and is completely task focused. It expresses the skills, qualifications, relevant experience, references and acceptability at interview.

Suitability can be regarded as an indicator for the future and how that person is going to be integrated in his future team. It is team focused and expresses behavioral tendencies, temperament, aptitude and role fit.

After matching these two important aspects, there are four different outcomes for the suitability/eligibility argument expressed in the Table 2.1.

The ideal fit would be someone that is at the same time suitable and eligible. That kind of person is considered to be a short stayer as it fits, without any difficulty, in the team and tasks that are going to be assigned to him/her.

The long stayers are often considered to be a surprise fit as they have all the behavioural tendencies and temperament to fit in easily in the future team but still have to develop the skill and qualifications need to achieve excellence.

The problem in recruiting someone for a team comes when that person is not suitable for his/her future team. Conflicts and major clashes can arise which can bring performance issues to the team. A poor fit is someone who has the necessary skills to perform their tasks with success but cannot develop a good relationship with his/her teammates which may lead to unnecessary problems.

Someone that should not be even considered for recruitment is called total misfit in which that person does not have neither the necessary skills to successfully do their tasks nor does that person has the temperament or adequate role to fit positively in the team.

2.10.6.10 Team role balance

The model developed by Belbin is not worried with the behavioural patterns (the team roles) per se but with the ways in which the roles develop, change and interact with other patterns of behaviour over time.

Belbin defends the idea that high performance teams are characterized by having a balanced representation of all team roles. That hypothesis defended by Belbin assumes that if all team roles are present in a team then it will perform better than other teams without that equilibrium.

Belbin also considers that the natural tendency of a person to behave in a certain manner (the team role) should be distinguished from the functional role that refers to the technical skills relevant to the job that has to be done. In consequence, several persons may have the same functional role but vary greatly in their team role.

A lot of studies were made to test the team balance performance hypothesis and the results that were captured prove Belbin's original hypothesis and they are all described in the paper made by Arizeta, Swailes and Barbara Senior about the validity of Belbin's Team Role Theory. [ASS07]

2.10.6.11 Team roles and innovation

In Management Teams, Belbin presented two team roles dedicated to innovation and creativity: the Plant and the Resource Investigator. The differences between the two roles in terms of innovation are related with the source of innovation. Plant initializes the innovation process from within using the team as the source (internal source) while the Resource Investigator is someone who uses ideas from the external environment of the team, transforms them into something tangible and acts as a technological gatekeeper that keeps the organization well-informed and acts as information holder. [Hen01] [Bel10]

Stevens developed a study about the effects of roles and personality characteristics on software development team effectiveness and tested the impact of the presence of certain team roles in some areas of interest in software development: mean-time to complete a task, leadership, innovation and decision-making issues. Regarding innovation, Stevens decided to make experiments to demonstrate the importance of innovative Plant members to a team. Teams with no Plants, with some Plants and team in which all team members were Plants were analysed. Stevens reached the conclusion that there is a big difference between the "All Plant" teams and the "Some Plants" but there is not enough evidence to distinguish the "No Plant" group from the "All Plants" or the "Some Plants" groups. [Ste98]

2.10.6.12 Belbin's Team Role Theory and Software Engineering

Belbin's team role theory defends the matching of functional roles and team roles. The team role is related with the kind of contributions a person makes to the group effort. Those efforts are not directly tied to job requirements and are often unnoticed. A functional role embodies the the literal work as in the intellectual work and specific goals related to the job of the person.

Mills/Baker and Brooks studied the importance of pairing a single and highly talented programmer with a secondary skilled gifted assistant. Being willing and able to communicate easily on the same level is a crucial characteristic for these kind of role in order to have a successful performance without conflict or personal agendas entering the equation. [Sch01]

There are some combinations of Belbin's team roles that are known to result in problems and difficulties within the team . Including or avoiding certain team roles or combinations of team roles may prevent the team from suffering those difficulties.

For example, having more than one Shaper in the team may be disastrous because the Shaper is prone to be abrasive, implacable and inflexible. [Ste98]

In the case of Pair Programming, a perfect pairing according to Belbin's theory would be a Plant and a Monitor-Evaluator because while the Plant has the tendency to generate new ideas and strategies that are related with the project's major issues and look for other ways to attack the team's problems, the Monitor-Evaluator has the capacity to make sharp judgments and analysis of all the factors that may influence a team's decision while being able to hold his own opinion in a debate with a Plant. [Sch01] [Bel10]

One software development methodology that has already enjoyed great success with Belbin's Team Role Theory is Extreme Programming. The experiments made with that methodology indicate, again, that the pairing should be made with the Plant and Monitor-Evaluator team roles and that having one Plant helping another Plant that is experiencing some problems is unlikely to solve the problem.

The study made by Stevens about the set of specific team roles important to software engineering was quite important in order to better understand how to solve certain problems and achieve a good standard of performance. Software Engineering is a discipline that requires creative, working solutions to be applied to understand problems. This requires three elements: leadership and direction for the team, intelligence and creativity by which ideas can be generated to solve exquisite problems. Regarding leadership and the Belbin's two team roles related with that task (Co-ordinator and Shaper), Shapers, seem to be more prevalent in software development than the Co-ordinators. Teams with a single identifiable leader perform better than other types of teams. [Ste98] [Sch01]

Fábio da Silva e Ana César made an experimental research on the relationships between preferences for technical activities and behavioral profile in software Development. They considered the following activities:

1. Analysis - consists in identifying the user's needs and conceiving and evaluating the system;
2. Developing - transform the system's specification into source code;
3. Testing - Executing tests to the system in order to find possible errors and bugs;
4. Revision - Evaluate the project's and planning's artifacts in all phases of software development life cycle;
5. Management- Plan and manage the risks of the project.

Functional Role	Team Role							
	CO	TW	RI	SH	IMP	CF	PL	ME
Scrum Master	+++	+	0	0	0	0	---	0
Product Owner	+	-	+	+	++	+++	---	+++

Table 2.2: Correlation between Belbin's team roles and SCRUM methodology members

The authors reached the following conclusions about the relations between activities and team roles:

- **Analysis - Shaper (-)** Expected negative correlation as the analysis process means to discover and investigate the client's needs while the Shaper team role is abrasive, anxious and arrogant and may offend others easily;
- **Development - Implementer (+)** Transforming plans into actions is the natural course of action of the Implementer and so this positive correlation is expected;
- **Development - Co-ordinator (-)** Consistent with the negative correlative between Management-Implementer and Development-Implementer;
- **Development - Plant (+)** Stevens (1998), Schoenhoff (2001) and Rajendram (2005) corroborate this correlation specially when there are non-trivial problems in the development phase ;
- **Development - Resource Investigator(-)** This correlation can be easily understood as the Resource Investigator tends to lose interest in the tasks after the initial enthusiasm;
- **Revision - Team Worker(-)** This negative correlation is not made from the theoretical framework and should be a target of further investigation;
- **Revision - Completer Finisher (+)** "Looking for details" is something that is a common activity of a Revision process and it is the expected behavior of a Complete Finisher;
- **Management - Implementer(-)** Being inflexible and slow to respond to new opportunities does not allow a good management performance from an Implementer;
- **Management - Co-ordinator (+)** Positive correlation as described in França e da Silva's (2007) work;
- **Management - Resource Investigator (+)** Positive correlation as described in Fernandes e da Silva's (2007) work. [dSC]

  Ferreira et al. proposed a correlation between the Belbin team role profiles and the SCRUM team members. Several experiments were made in software development teams and there were several conclusions taken about the roles of Scrum Master and Product Owner. The Table 2.2 illustrates the conclusions achieved in which a plus (+) sign is equivalent to a

positive connection, a negative (-) means a negative relation and a zero (0) means a neutral relevance. [FdSL07]

2.10.7 Assessment of team role and personality

2.10.7.1 Belbin's Self Perception Inventory

The Belbin Self Perception Inventory (SPI) is one of the two measurement devices used to determine a person's role. The other tool is known as the Observer's Assessment (OA). The SPI was created with the purpose of being a tool with which a person could discover the team role for which they are best suited. The OA is used purely to obtain a peer-based estimation of a person's role but is only available through the company Belbin Associates. Although being subject of a good amount of controversy, this framework enjoyed widespread use among management and is used as a valid psychometric tool by psychology and management professionals.

The tool was subject of criticism by Furnham, Steele and Pendleton in which the authors claimed that the SPI lacked internal reliability and that the ipstative nature of the test was inadequate to evaluate the behaviour that someone has shown. [FSP93] In the other end, Dulewicz elaborated a paper in which we confirms the construct equivalent of the SPI and OA and offers empirical evidence that supports the reliability and validity of the Belbin's model. [Dul95]

The SPI is a behaviour-based questionnaire that consists of eight sections and each of those sections contains 10 statements. Within each section, the employee has to distribute points to the statements based on how they feel those statements apply to them just as long as the sum total of points for the section is 10. Only integer number must be allocated to the statements and extreme cases as giving 10 to only a statement should be avoided. Each statement is related to one of the eight team roles. In the end of the questionnaire, the data is normalized in order to obtain a degree of incidence in one or more team roles (that degree is considered to be Low, Average, High or Very High) according to a table that shows the various ranges of points for each degree in the various team roles.

2.10.7.2 Team Climate Inventory- TCI

The Team Climate Inventory is the result of a study that had the objective of developing a multidimensional measure of proximal work group climate for innovation based upon deconstructions of group climate and upon a hypothesized four-factor theory of climate for innovation developed by West in 1990.

West proposed a four-factor model of work group innovation, hypothesizing that four major factors of climate are predictive of innovativeness: vision, participative safety, task orientation and support for innovation.

Vision is an idea of a valued outcome which represents a higher order goal and a motivating force at work. Having a focus and direction for the future efforts is essential to provide a chance for a work group with a clearly defined objective to develop new goal-appropriate methods of working. Vision can be divided into four different parts: clarity, visionary nature, attainability and

sharedness. Participation safety happens when the contingencies surrounding the work group are such that involvement in decision-making is motivated and reinforced while the environment is perceived as interpersonally non-threatening. Task orientation is characterized by being a shared concern with excellence of quality of task performance in relation to shared vision or outcomes. It is a general commitment to excellence in task performance couple with a climate of constant analysis and improvement. Support for innovation can be described as the expectation, approval and practical support of attempts to introduce new and improved ways of doing things in the work environment. Enacted support is vital to group innovation like for example the resources being made available is necessary to develop innovations. [AW98]

The four-scale original version of Team Climate Inventory consisted on a 61 item questionnaire that covers the four factors of work group innovation with different scales for different items.

In this study, it was used the short-version of the Team Climate Inventory that can be seen in Anexo E.

2.11 Social Climate and its impact on the organization's innovation capability

All innovations begins with creative ideas. New processes, new product features or new services depends on a person depend on a person or team having and developing a good idea beyond its initial state.

Teresa Amabile's work turned out to be the foundation of the study in the impact of the social environment in the creativity and innovation capabilities. Amabile created a conceptual model in which it was described the main factors responsible for influencing the capability to innovate or to be creative . The author developed an instrument to assess adequately the various work environment dimensions that may have an impact in innovativeness called KEYS.

2.11.1 KEYS

KEYS was developed through a collaboration between Teresa Amabile and the Center for Creative Leadership. It was designed to provide a reliable and valid assessments of organizational work environment perceptions that are likely to influence the generation and development of creative ideas.

KEYS is a questionnaire with 78 items in which 66 of them describe the work environment and the remaining 12 are related with creativity and productivity. The 66 items related with the work environment originated 8 environment scales by conceptual grouping and examination of principal components factor analyses of those items. 6 of those environments assess proposed stimulants to creativity while 2 scales are related with dimensions that should lead to lower creativity. The KEYS assessment was subject of a dense statistical study to prove that it had convergent validity with a measure of work environment in organizations (the measure that was chosen was the

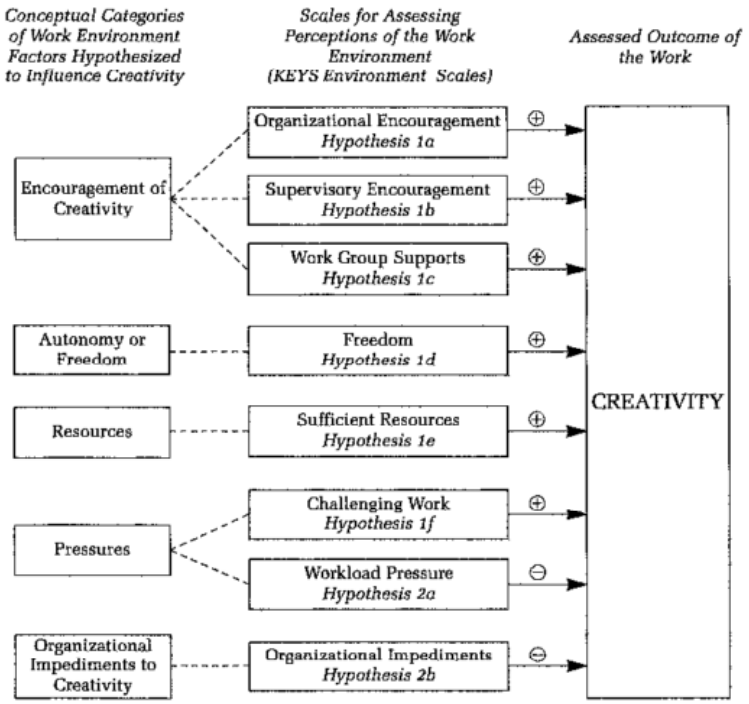

Figure 2.14: Conceptual model underlying assessment of perceptions of the work environment for creativity (Amabile 1996)

Work Environment Scale, a well-established general measure of work environments in organizations) and discriminant validity in order to demonstrate that KEYS responses do not simply reflect individual characteristics of respondents. To do so, it was used the Kirton Adaption-Innovation Inventory to compare the results of the measurement of creative cognitive capacity and Work Preference Inventory to see the influence of an individual's intrinsic or extrinsic motivation in his/her creativity. With that said, KEYS is considered to be a reliable and useful test to assess a team and organization environments for creativity and innovation but it is necessary to complete a certification in order to provide feedback about the results of the questionnaire. [ACC+96] Figure 2.14 illustrates the Amabile's model.

2.11.2 Work environment dimensions with impact on innovation capability

In order to obtain a proper climate for innovation, it is extremely important to know with a certain depth the dimensions of the social work environment that affect the innovation potential of an organization:

- **Organizational encouragement:** Related with the encouragement of risk taking and idea generation and a valuing of innovation from the highest to lowest levels of managements. Research made on creativity at work has demonstrated that people tend to produce more useful and unusual ideas if they have the chance/permission to do so by the situation in which they are involved or by explicit instructions of higher management ranks. A fair and

supportive evaluation of new ideas, a reward and recognition of creativity and a collaborative idea flow across the organization are important aspects of organizational encouragement.

- **Supervisory Encouragement:** Research has been made that point out the role and importance of project managers or direct supervisors especially in the area of goal clarity and supervisory support of team's works and ideas. Goal clarity is considered to be extremely important in creative behavior and the providing supportive evaluation is often considered to be a way of not undermine the intrinsic motivation that is crucial for innovation and creativity.

- **Work group encouragement:** Fostering a team member diversity and mutual openness to ideas, constructive challenging of ideas and a shared commitment to the project are ways to encourage creativity within a team or group.

- **Freedom/Autonomy:** Creativity and generation of innovative ideas are fostered when individuals or teams have autonomy in their day-to-day work. Having a sense of ownership and control of their work and their own ideas is considered to be truly supportive of creative attitudes.

- **Resources:** A number of researchers have suggested that resource allocation to projects is related to the levels of creativity that a team shows in a certain project. Besides that, proper resources affect the perception of the intrinsic value of the project that are being done, consequently affecting the innovation and creativity outcomes.

- **Pressures:** There are still misguided informations about the the effects of pressure on creative work in organization. In one hand, there is the belief that extreme workload pressures could undermine creativity but at the same time, a certain degree of pressure is perceived as having a positive effect on creative tasks. The difference between the two can be define as one being a truly excessive work pressure (undesirably high levels of pressure) and the other being considered a challenge in which the performance of levels of the team and the individual arise above normal standards;

- **Organizational Impediments to Creativity:** Internal strife, conservatism and rigid and formal management structures within the organization are considered to be impedements by Amabile. [ACC+96]

de Faria published a study in 1996 about positive and negative aspects that have an impact on creativity as stimulants and obstacles. [dFdA96] The stimulants of creative task encountered were the following:

- **Physical environment:** Proper physical environment in terms of furniture, light, temperature and conditions to have proper innovation activities;

- **Communication:** Existence of communication channels that allow the knowledge and the internal informations to exchanged;

- **Challenges:** Challenging tasks that stimulate the individual's full potential;
- **Organization's structure:** Reduction of hierarchical levels, more flexible norms and less bureaucracy;
- **Freedom/Autonomy** Autonomy to decide how an individual should be able to do his work and act differently, if necessary, than his teammates;
- **Participation:** Being pro-active is valued, having more power is in work area and being more taken into account in the decision making and problem solving process;
- **Material and technical resources:** Machines and equipments, financial and material resources to produce and implement new ideas;
- **Rewards:** Proper salary and benefits policy that values innovation and creativity;
- **Management support:** Posture of receptivity, flexibility, acceptance and stimulus of new ideas;
- **Team support:** Team member acceptance, favorable interpersonal relations that stimulates the innovation process;
- **Organizational support** Recognition of creative work, existence of mechanisms to help the development of innovative ideas, planned and definition of innovation milestones and presence of a suited innovation culture
- **Training/Coaching:** An organizations that invests in the training and coaching of the creative potential of its collaborators will collect innovation gains in the future.

The encountered obstacles by de Faria were the following:

- **Physical environment:** Lack of space to have all the collaborators in a comfortable way, constant noise in the workplace, absence of natural light and existence of non pleasant smells;
- **Characteristics of management:** Management that does not hear the collaborators, do not give credit or value to generated ideas and undervalue the creative potential of the employees put in danger the entire innovation process.
- **Characteristics of the task:** Repetitive tasks with no challenge are not prone to develop creative behaviors;
- **Communication:** Absence of communication channels that do not allow to have access to information and knowledge is an obstacle to the innovation process;
- **Culture of the organization:** If the culture of the organization is characterized by a risk-evasive posture, by the fear of change and by the non-acceptance of new ideas, the innovation process has a low probability of having success;

- **Structural organization:** A rigid, bureaucratic and authoritarian organization always struggles in the creative process;
- **Lack of freedom/autonomy:** Not having the chance to think outside the box and do/experiment things that are not expects is an obstacle for the innovation process;
- **Lack of training/coaching:** Not teaching and giving training to the collaborators about how to express their creative and innovative potential is a negative aspect in a set of policies that want to boost the innovation outcomes;
- **Political and administrative influences:** Constant changes in the management staff with a constant redesign of the pretend goals do not help the innovation process to be successful;
- **Interpersonal relations:** Having a good level of dialogue, group activities and confidence between all team member is essential to the success of the innovation process.
- **Rewards:** Low salary and no rewards for the potential outcomes of the innovation processes do not stimulate the innovation process.
- **Workload pressure:** Intense time pressure and excess of tasks do not permit a successful innovation program.

2.12 Summary

The state of the art is quite extensive regarding innovation and the impact of the work environment, both social and physical, in the innovation process.

All studies point out that a true care about the context surrounding the staff is essential to guarantee a successful innovation program that brings important additions to the organization's products or processes.

However, there's is low number of studies that are related to the physical and social context around innovation in a software house and that is gap that should fulfilled.

Chapter 3

Problem description

The goal of this chapter is to provide a deeper introduction and analysis of the problem. In a first phase, it is presented the results of the first weeks of the work that was done. That work consists of the diagnosis made of the organization as a whole and, especially, the history of the innovation process in the software house. After that, a summary of the investigation is exposed followed by an explanation of the hypothesis that this study tries to prove.

3.1 Initial diagnosis of the software house: the initial conditions and the history of the innovation process

The work that was done in the software house for this Dissertation thesis began with a diagnosis of the history and actual state of the software house regarding all the environmental aspects that can influence the innovation process.

That initial work consisted of interviews with key personalities of the organization in order to better understand the past and actual state of the innovation process and all the dimensions that have a possible positive or negative effect in it. Besides that, focus groups techniques were used to gather detailed information from development heads, development management and developers about all sorts of innovation determinants that might be present in the organization. Finally, ethnographic observation was used to better understand the culture of the organization and how the innovation process truly occurred in a normal day of the software house.

3.1.1 Recent past and present of the software house

The organization started in 1993 and, since the beginning, it has a commitment to focus in developing modern solutions that had the capability to respond easily to the client's actual and future needs. That commitment was considered by all the key personalities of the software house as one

of the main reasons as why the organization evolved into one of the European companies with greatest growth potential according to a well regarded financial group.

Innovation was always considered to be an important dimension and aspect of the corporate strategy of the organization. A policy of investment in Research and Development was always the plan of the organization to keep producing,developing and integrating continuous innovation in the solutions by which the software house has become known for.

The past was always characterized by that strong will in develop and introduce innovative features in the products made by the software house. However, this organization suffers from constant pressures that are considered to be an obstacle for a high performance innovative culture. Both external and internal pressures were analyzed and witnessed for the effects of this diagnosis.

The software house developed, throughout the years, a set of solutions that have the goal to maximize the efficiency of other organization's processes. Those consistent products are extremely complex due to their nature and in order to grant that these kind of products achieve good levels of robustness, consistency and scope coverage. Managing the project's scope and time is extremely important because this software deals with with a sensible range of areas that include wage processing or standards related with the tax system.

World's political system is consistently changing and keeps creating instability in the laws and norms that are applied to the employees, employers and organizations in general. That instability creates a tremendous pressure in the software house because it is mandatory to have the software always ready and compliant with every law, norm or code of work. To get things worse, as the software house has already expanded its business to other countries besides Portugal, the number of specific laws and norms that need to be covered increase with the number of countries in which the software has representation.

The specificity of the requirements that need to be implemented is so high that can be considered to be a huge pressure in the development teams as they have strict deadlines to submit their work to the end customers and business partners due to the constant changes of legislation.

With that said, it is quite easy to understand that the actual state of the solutions offered by the software house is a product of many years of work. Continuous perfection of the solutions that are offered have to main goal of guaranteeing as much efficiency, robustness and security as possible. Those years given to a certain solution or product to turn it into something worthwhile and with a market share that fits the company's needs have some costs and risks associated to them. The evolution and delivery of innovative features was made using the same technological background which now kind of acts as an obstacle to introducing innovative features in the final solution.

Discovering how to deliver innovative features or products while having to deal with constant changes and instability in the master requirements of several projects is a hard and painful task as it involves a great variety of factors that are both internal and external to the software house.

Several activities related with innovation within the company were made in order to boost the innovation process outcome and to get the most of each employee, making sure that everyone has their part and space in the innovation process:

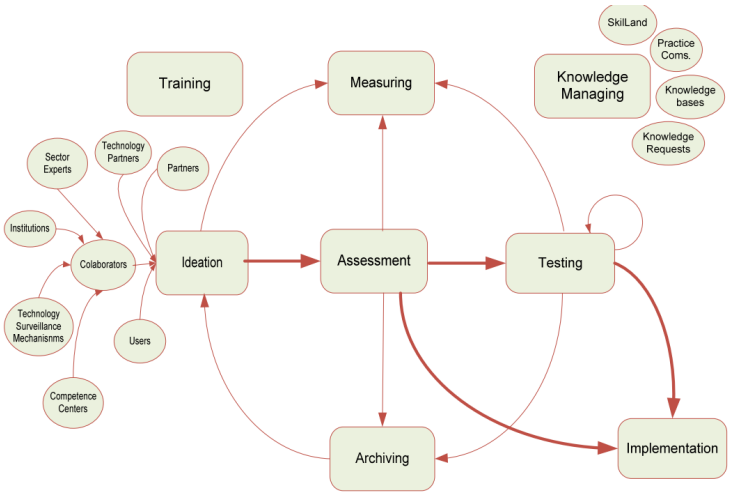

Figure 3.1: Innovation process as defined by the Innovation Framework

- **ThinkTanks** was an activity that was designed to have a space, in the form of meeting or focus groups, where the staff responsible for the User Experience of the solutions would confront the development teams with issues that needed to be addressed. The original goal of this activity was to boost a small innovation framework where the two teams could find innovative solutions to the problems that were being encountered by the User Experience team and the final users of the software. The other goal of this activity was to have a way to reach a solution and resolving conflicts between the development teams and the User Experience team.

- **Public space for the presentation of ideas** was as activity that consisted in opening a space and sponsoring the presentation of the employees' ideas. Middle-level and top management would attend and watch a presentation of the idea of the employee that should, by the time, already developed a prototype of that idea in order to get a better perspective of its final value to the solutions of the software house. This activity was normally done after the normal work hours and eventually died due to the lack of presentations.

- **Argonautas** is an activity that still exists. However, the more specific details of this activity have been changed throughout the years. This activity can be easily compared to the well known and famous policy usually called "Time-Off". This activity pretended to gather groups or teams people from different areas in order to get different perspectives of potential things to improve and innovate in the solutions of the software house. First, the teams had one day off from the normal projects every two weeks to work in their idea or project inside the organization's headquarters. In the second round of the activity, the groups or teams could meet anywhere to investigate and do their research. Nowadays, the activity consists of people getting together to develop some special idea or a developer can obtain

an "investigation scholarship" in order to study and do some research about a specific topic or technology. In the end, there is a presentation about what the team achieved during the **Argonautas** project. The actual goal of this activity is to boost the innovation process by creating the space to innovate (one of the things noticed during the the initial diagnosis) and to create a culture of knowledge and information sharing. There is a genuine attempt to make this process as more informal and without too many rules as possible. In the beginning, the outcomes of this exercise were considered to be slim and short but the process has improved during this last years and the last results were considered to be positive by the management ranks.

- **Golden card** is one possible source of innovation time to be used in the regular projects of the software house. A team can request a golden card to have 3 days to implement innovative ideas into a regular project. The attribution of the golden card is dependent of the manager approval.

- **TechTalks** is a challenge that happens once every year where groups of people present a small prototype of an innovative idea or an innovative feature incorporated into a project that can be considered to have a positive and meaningful impact in the actual state of the solutions that were developed by the organization. The **TechTalks** day is quite special because a big part of the organization's headquarts is transformed into a kind of science fair in which the teams have a place to show and sell their idea to everyone. In the end, prizes are awarded to the winning team(s). This challenge has brought a lot of positive results to the organization and it is an activity that is quite appreciated by the development teams.

- **Innovation Framework** was a big project in which a lot of effort has been made to create a culture of innovation in the whole organization. An Innovation Observatory was created that consisted of an independent and multidisciplinary group of employees from the various areas of the organization: Marketing, IT, Human Resources, Consulting, Finance, etc. Their responsibility was to select and promote the Innovation Framework and the ideas that were generated by it. Four levels of innovation were defined: technological innovation, process innovation, product and service innovation and business model innovation. After understanding the innovation vectors and taking into account the corporate strategy, an innovation process that can be seen in Figure 3.1. Finally, the whole Innovation Framework was completed with the creation of an idea management platform where employees could present their ideas and receive feedback from the entire organization's community and with that, creating a rating mechanism and the opportunity of having an internal marketing culture. This project was quite successful and had a lot of positive reviews in the first phase of its implementation. However, the extreme formality associated to the process was the main reason for the end of the activity.

Facing the problems described in the initial diagnosis, the top ranks of the organization's management staff decided to make three huge changes that are still having an tremendous impact in the normal/daily work in the company:

- **Change to a new headquarters** The change to the new headquarters was a tremendous highlight in the history of the company and it was designed to provide all the necessary conditions to the development teams to do their job in the most efficient way possible. The dimensions of the physical environment that have an impact in the innovation capability of the employees were taken into account turning this change into an important point of the history of innovation of the organization.

- **Change to an agile software development methodology** The adoption of the SCRUM software development methodology was made with two big goals that are essential to innovation: reducing time to market and empowering teams. Time to market is considered to be essential to gain a fair market share and empowerment is acknowledged to be a mandatory condition of any innovation team or individual.

- **Organizational structure change** The change in the whole organization was a consequence of an adoption of the new software development paradigm. In order to have a better alignment in the whole organization, a structural change was made with the objective of successfully empowering the development teams. Besides that, this change has the objective of fully promoting a culture of innovation by allowing an easier way of accepting new people that can change the mindset regarding innovation of the other employees of the organization. With empowerment and a manager that acts close to team and has a role of supporting and help managing the difficulty that is to deal with some emotion that the innovation process bring to the team as for example, dealing with the fact that sometimes the person has the idea is not the one of receives the credit for it. Finally, the recruitment process is now aligned with the new performance evaluation and managing system. More than just looking at the key performance indicators, the Human Resources department is keen in evaluate if the employee has a good performance in areas like innovation, leadership or passion for excellency.

3.1.2 Investigation summary

This subsection of this chapter has the objective to explain the initial problem of this Dissertation.The observed aspects of the initial diagnosis that needed attention were mixed into a one big problem that can be divided into smaller problems.

The goal of this research was to examine the impact of the work environment in the innovation process of a software house. Both the physical and social environments were taken into account in this study. However, they were analyzed in different levels of detail.

The goals of this research and study were the following:

1. Perform a diagnosis of the impact of the former physical environment in the capability of an employee to innovate;

2. Perform a diagnosis of the current conditions provided by the actual physical environment and its impact in the innovation capability of each employee.

3. Test and measure the innovative work behaviors of the developers;

4. Test the social environment for innovation based on the Team Climate Inventory done by all the development teams;

5. Determine if certain team roles are drawn into the innovation phase of the software development;

6. Determine the teams that need some adjustment considering the Team Climate Inventory, the Belbin Self-Perception Inventory and evaluation of the managers concerning the aspects of leadership and innovation;

7. Retest sample participant with the Team Climate Inventory in the context of experiment teams. Use retest results to explore the impact of team building activities in the social environment of the team regarding innovation.

8. Present a list of recommendations with possible adjustments and guidelines for future recruitment according to the balance of team roles or lack of it and the evaluation made by the new performance evaluation system of the organization.

Eventual results supported the following eventual conclusions:

1. The physical environment has a meaningful impact in the innovation capability of the development teams;

2. The new headquarters was designed according to the guidelines of designing for innovation;

3. A software engineer's behavioral tendency has an effect on his team's success;

4. The Plant and Resource Investigator team roles are necessary in a team that is characterized by its high performance regarding innovation;

5. High scores in the test of Innovative Work behaviors are related with Plant or Resource Investigator team roles;

6. Team building activities have a positive impact in the team's climate for innovation and in the presence of innovative work behaviors;

3.2 Summary

In this chapter, it was provided a description of the recent past and present state of the company regarding the innovation determinants. Taking that into account, the objective of this study and research is to prove or to give scientific background for future studies in that innovation in a software house is truly affected by the physical and social environment that surrounds the teams and that the top-level managers should be aware of that in order to guarantee the success of their organization's innovation process or program.

Chapter 4

Implementation of the solution

This chapter is dedicated to the presentation of low level details of the solutions proposed to the problem that was exposed in the previous chapter.

In the end of this chapter, the evaluation of the process will be discussed and presented.

4.1 Physical environment and its impact on the innovation capability

4.1.1 Photographic diagnosis of the physical environment

Based on the literature exposed in the chapter related with the state of the art, it was made a diagnosis of the presence or absence of the physical environment dimensions that affect the innovation process of an organization.

The first course of action consisted on taking a collection of photos that could express and be related with the dimensions of the physical environment that affect the innovation capacity. Photos were taken at the former headquarters of the conditions of work of the development teams. The goal of the photos was to illustrate and document the general opinion of the developers about the physical condition of the former headquarters of the organization.

Development rooms, community area with games and table tennis, meeting rooms or the general auditorium were documented for future analysis.

Once the process of moving to the new headquarters of the organization was completed, a new round of photographic diagnosis occurred. Again, the photos were taken with the goal to document the presence or absence of the dimensions of the physical environment that have an impact in the innovation capability as the presence/absence of appropriate furniture, indoor plants or flowers, calming colors, window views to nature and sufficient quantity of light. In this second round, the development rooms, meeting rooms and community areas were the rooms analyzed.

The repertoire of photos of the former headquarters can be seen in Appendix B.

The repertoire of photos of the new headquarters can be seen in Appendix C.

4.1.2 Questionnaire about the impact of office design on innovation

After the initial documentation made with photos of the former headquarters, it was tremendously important to check what was the opinion of the development team about the conditions that were provided by the organization by their physical environment.

4.1.2.1 The Study Participants

The participant subjects for this study were the developers of the software solutions that the company designs and produces.

The questionnaire was answered by all the team members of the 10 different development teams. All types of team members from the Scrum methodology from developers, testers to Product Owners answered the questionnaire.

95% of the developers successfully answered the questionnaire (38 developers out of 40). There were two developers that were unable to answer the questionnaire due to a long absence of work for various reasons.

4.1.2.2 Questionnaire

The questionnaire was adapted from the one created by Amina Hameed and Shehla Amjad for the Journal of Public Affairs, Administration and Management. Instead of trying to discover exclusively the impact of increased personal control and comfort needs of employees in the productivity of the employees, this slight adaptation was made to include the topic of innovation in the questionnaire and make the developers think about how the physical environment can be an obstacle or a stimulant element of the innovation process. [HA09]

The significance of the study was well described in the paper of Hameed and Amjad. The study developed a regression model to calculate the employee productivity with the following predictor variables: furniture, noise, lightning, temperature and spatial arrangements.

Due to the small change in the questionnaire, it is important to determine once more that the scale that is being used in the questionnaire is uni-dimensional and that the set of items asked are closely related as a group as in that this questionnaire has reasonable internal consistency. For that, the Cronbach's alpha for this questionnaire was calculated in order to check the reliability of the test. A Cronbach's alpha of 0.70 or higher is considered to be "acceptable" in most social science research situations.

The questionnaire that used to collect the answers of the developers can be seen in Appendix E.

4.1.2.3 Possible analysis

Once all the available developers answered the questionnaire, an analysis of the physical environment of the old headquarters was made. There were four dimensions that were evaluated in the questionnaire given to the development teams:

1. The workplace is comfortable enough so that the developer is not physically tired in the end of the day;

2. The physical environment influence how well can a developer expose an idea to his/her team mates and superior managers;

3. Silence is a characteristic of the workplace of the organization;

4. Appropriate furniture is important and has an impact in the innovation capability of the developers.

Since there were more than one development room with different characteristics regarding the dimensions of the physical environment that affect the innovation capability especially the exposure to the light and to exterior views, it is quite important to cluster the results by team and compare the results of teams in different development rooms.

4.1.3 Creativity Development Quick Scan Analysis

Once the process of moving to the new headquarters of the organization was completed, it was extremely important to check the recent opinions of the developers of the company. However, since the moving process was completed a few weeks before the end of this study, it was not important/significant to measure the impact of the office design in the innovation capability of the development teams. Taking that into account, the Creativity Development Quick Scan was the selected test to confirm the opinion of the developers about the important dimensions of physical environment with impact in the innovation outcomes of the teams.

4.1.3.1 The Study Participants

The participant subjects for this study were the developers of the software solutions that the company designs and produces.

The questionnaire was answered by all the team members of the 10 different development teams. All types of team members from the Scrum methodology from developers, testers to Product Owners answered the questionnaire.

90% of the developers successfully answered the questionnaire (36 developers out of 40). There were four developers that were unable to answer the questionnaire due to a long absence of work for various reasons.

4.1.3.2 Questionnaire

The Creativity Development Quick Scan was already exposed in Chapter 2. The main objective of the Creativity Development Quick Scan is two classify the importance that the developers give to some dimensions of the physical environment that affect innovation and the presence/absence of them in the new headquarters.

The dimensions that the developers from the company rated the importance to the innovation process and its presence/absence in the new headquarters were the following:

1. **Furniture**
2. **Indoor plants**
3. **Privacy**
4. **Window view to nature**
5. **Luminosity**
6. **Silence or positive sounds**

The questionnaire that used to collect the answers of the developers can be seen in Appendix F.

4.1.3.3 Possible analysis

With the Creativity Development Quick Scan, the important analysis to be made is the one related to the differences between the importance given to the dimensions present in the framework of the questionnaire and the presence/absence of them in the new headquarters.

4.2 Team building activities and its impact in the innovative work behaviors and in the team climate

4.2.1 Process

In order to obtain some useful insights about the impact of team building activities on the innovative work behaviors shown by the developers of the organization and on the climate that exists in the development teams for innovation, it is quite important to understand clearly the scientific process that is going to be followed.

The Innovative Work Behaviors (IWB) test and the Team Climate Inventory (TCI) test were both performed in the development teams in two occasions: in the beginning of the work in order to understand and document the initial state of the organization and of the development teams regarding innovation and after the team building activities that were performed in some teams. Once there is a theoretical background of the initial state of the organization regarding innovation, a cause-effect relation can be built. With the team building activities as a treatment for the problems encountered and already exposed, there is a dependent variable that is the result that still needs to be subject of research. After the "treatment", a treatment-result relation is built and the results are analyzed. The whole process is quite similar to the one in Figure 4.1

Two sets of hypothesis were generated in order to express mathematically the possible conclusions that the study wants to reveal. Regarding the innovative work behaviors, and taking into

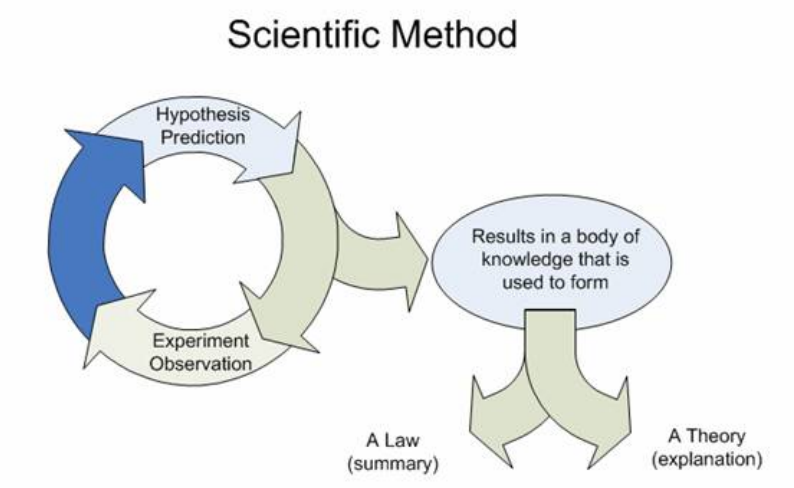

Figure 4.1: Scientific process (Douglas Adams)

account the dimensions that affect the innovation process outcome, it is expect that team building activities have a positive effect on the innovative work behaviors (IWB):

- Ho: $I\bar{WB}2 = I\bar{WB}$
- HA: $I\bar{WB}2 > I\bar{WB}$

, where $I\bar{WB}2$ is the mean of the second measurement of the IWB (after the team building activities) and $I\bar{WB}$ is the mean of the initial state of developers regarding innovative work behaviors.

The other set of hypothesis is related with the social environemnt of the teams. Respecting the team climate for innovation, and taking into account the dimensions that affect the innovation process outcome, it is expect that team building activities have a positive effect on the team climate for innovation (TCI):

- Ho: $T\bar{CI}2 = T\bar{CI}$
- HA: $T\bar{CI}2 > T\bar{CI}$

, where $T\bar{CI}2$ is the mean of the second measurement of the TCI (after the team building activities) and $T\bar{CI}$ is the mean of the initial state of development teams regarding the social climate for innovation.

General statistical measures will be analyzed and a Student t-test will be performed in order to evaluate the hypothesis that were assumed in the beginning of the study.

4.2.2 Innovative Work Behaviors Measurement

The IWB was already exposed and presented in the Chapter 2. It is now important to describe some specific details of the implementation of the measurement of the innovative work behaviors. Each developer has to describe how often does he/she have certain behaviors that are directly

connected to the innovation process. For each behavior, the developer rates the frequency of the behavior in a 4 item scale:

- "Nunca" means never and zero points are awarded if the developers says that he/she never has that behavior in the normal activities of the organization;
- "Raramente" means rarely and one point is awarded if the developers states that he/she rarely has that kind of behavior in the daily routine of the company;
- "Frequentemente" means frequently and two points are awarded to the developer if he/she expresses that that behaviors often occurs;
- "Sempre" mean always and three points are awarded to the developer if he claims that that behavior happens all the time in the daily life of the software house.

The sum of all the points collected throughout the set of behaviors is equivalent to the individual portion of the IWB. The questionnaire is based on self-perception and realizing that sometimes self-perception is not entirely equal or related to what really happens, the final grade that is awarded to each developer and that describes the frequency of his/her innovative work behaviors, depends on a grade given by the manager's perception of how important is the developer in the innovation process of his/her team and of the software house as a whole. The manager gives a grade from a range of 0 to 5 in which 0 means that the developers never has innovative work behaviors and 5 means that the developer is essential in the innovation process.

Finally, the IWB is calculated as the following:

- $IWB = 0.5 * iIWB + mIWB$

, where the iIWBM is the sum of all the points in the questionnaire and mIWB is the grade given by the manager.

4.2.3 Team Climate Inventory Measurement

Similar to the IWB, the Team Climate Inventory was already exposed in Chapter 2. This test is based on self-perception and has the objective of evaluating how the the developers thinks of his actions and his team mates' action in dimensions that are considered to be extremely important to the innovation process. The relation of the team with the objectives that were set, the amount of team work that exists in the team and some daily behaviors are all matter of evaluation in the TCI.

For each statement, the developer has to classify it in a 5-item Likert scale:

- "Discordo totalmente" means that the developer disagrees totally with the statement and for that he gets two negative points;
- "Discordo" means that the developer only disagrees with the statement and for that he gets one negative point;

- "Não concordo nem discordo" means that the developer neither disagrees nor agrees with the statement and for that he gets zero points;
- "Concordo" means that the developer agrees with the statement and for that he gets one point;
- "Concordo totalmente" means that the developer totally agrees with the statement and for that he gets two points.

Finally, the TCI is calculated as the sum of points awarded in each statement.

4.2.4 The Study Participants and the Activities

For the study of the impact of team building activities on the social climate for innovation and on the frequency of innovative work behaviors, three development teams were selected for the team building activities.

The team selection process was based on one criteria:

- Teams in different stages of group development according to Tuckman's Theory

The *Storming*, *Norming* and *Performing* phases were all covered by the three different teams. Getting a good diversity of types of teams is important for the success of the study.

The team building activities were selected considering the problems encountered in the teams and taking into account the final goal of the study: to boost the innovation process of the software house. The team building activities are described and exposed in Appendix A.

4.3 Team Role Balance

4.3.1 Process

Team role balance importance was already described in Chapter 2. In order to fully understand how well balanced and built are the development teams of the software house, it is necessary to perform the adequate tests to describe and characterize each developer's normal behaviors in the work context.

The Belbin Self-Perception Inventory was done by every developer of the software house to determine what are the predominant behaviors of that person and to assign a set of dominating Belbin team roles. As the Belbin Self-Perception Inventory is a self-perception test, a deeper validation of the data collected was necessary.

The managers were asked to characterize each developer according to the three different kinds of behaviors that Belbin exposed in his work and that were describe in Chapter 2

This validation of the managers is a way of replacing the Observer Assessment that Belbin introduced recently in his work. By that, this part of the study needs more research in order to obtain a stronger theoretical background.

Finally, a comparisons between the grade awarded by the team in the Innovation and Leadership parts of their work (from 0 to 5, where 0 is a behavior that is never done and 5 is a behavior that is done all the time) and the team role profiles that the team have is done.

4.3.2 Possible analysis

The analysis that will be performed can be divided into four different dimensions:

- Analyze the balance of team role profiles in each team. Considering that for a developer to be fit in a particular team role, he has to have a **High** or **Very High** grade in that team role, the goal for this part of the study is to analyze the predominant team roles that exist in a team and check if the necessary team roles for innovation are present;
- Compare the average team scores against the Belbin's scores for a positive balance of team roles;
- Check if the team roles of the Product Owner and Scrum Master of each team are the ones that the literature suggest that are the most correct for a productive and innovative team;
- Provide a list of recommendations for the Human Resource Department about possible rearrangements within the development teams and future recruitment processes.

4.4 Analysis of the results

4.4.1 Physical environment

The change that was made recently into a new headquarters tremendously changed the life of the organization. The former headquarters represented an example of some design errors that are correlated with dimensions of the physical work environment that affect the innovation process of an organization. Some characteristics of the old headquarters that affected negatively the innovation process according to the literature described and exposed in Chapter 2 are the following:

- No exposure to daylight;
- No window views to nature or the the exterior environment of the software house;
- Non adjustable furniture that allowed constant mobility;
- Individual work spots were divided from each other by a tall piece of glass that was an obstacle for frequent face-to-face conversations;
- Indoor temperature was unstable and often too high;
- Absence of informal meeting place to foster innovative discussions;
- Absence of indoor plants.

	Difference Furniture	Difference Plants	Difference Privacy	Difference View	Difference Luminosity	Difference Silence
Team 1	0	1	0	0	0	0
Team 1	1	0	0	1	-1	0
Team 1	0	1	0	-1	0	0
Team 7	0	0	0	1	0	0
Team 7	1	-3	0	0	0	-3
Team 7	-1	-1	0	1	-1	0
Team 7	0	1	0	0	1	2
Team 7	0	0	-2	0	0	0
Team 10	0	-3	-1	0	0	-1
Team 10	0	-1	-1	0	0	0
Team 10	1	-2	0	0	0	0
Team 10	3	0	0	2	1	0
Team 10	4	0	0	0	0	0
Team 5	0	0	0	0	0	0
Team 5	1	0	0	0	0	-1
Team 4	0	0	0	0	0	1
Team 4,9	0	0	0	0	0	-1
Team 4,9	-1	-1	0	0	0	-2
Team 9	0	0	0	0	0	0
Team 9	0	-1	1	0	0	1
Team 9	-2	-4	0	0	0	0
Team 9	0	0	0	0	0	0
Team 3	0	0	0	0	0	-2
Team 3	0	-5	0	0	0	0
Team 3	0	0	0	1	1	0
Team 2,5	0	-1	0	0	1	1
Team 2	2	-1	1	0	0	0
Team 2	0	0	0	0	0	0
Team 8	0	-4	-1	-1	2	1
Team 8	0	0	0	0	0	0
Team 8	3	0	1	3	2	1
Team 8	1	0	0	-2	-1	-3
Team 6	1	0	1	1	1	0
Team 6	0	0	0	0	0	0
Team 6	0	-1	-1	2	1	-2
Team 6	0	0	0	0	0	0
Total	**14**	**-25**	**-2**	**8**	**7**	**-8**

Figure 4.2: Creativity Design Quick Scan Results by team

Some of these examples can be documented and proved with the photos in Appendix B.

The results of the first questionnaire related to the initial conditions of the physical work place of the software house can be seen in Appendix G.

After careful analysis, it is possible to state and in the form of a summary of conclusions about the questionnaire made to the development teams in the beginning of the study:

- Regarding the comfort associated to the former work conditions provided by the physical environment, there is a mixed set of reactions in which there is not a predominant mind-set about if the work place is comfortable enough so that the developer does not get tired in the end of the day;

- There is a slightly positive opinion that the physical environment has an impact in the way that developers expose ideas;
- There is a slightly negative opinion about the presence and existence of silence in the company's workplace;
- Finally, the developers consider that a suitable furniture is essential to a good level of innovation capability.

Analyzing the answers of the second questionnaire, it is essential to try to understand the difference between the importance that the developers give to some dimensions of the physical work place that affect innovation and creativity and the actual presence of them in the new headquarters. Figure 4.2 exposes the results of the Creativity Design Quick Scan questionnaire. Each row represents one of the developers of the software house. In the last row, there is a sum of the all the differences between presence and importance of the dimensions above mentioned. With that is possible to conclude the following:

- **The Furniture** is considered to be more than adequate for the innovation process of the software house as it has a high positive value in the sum of differences between the value of its presence and importance;
- **Plants** are considered to have an importance in the innovation process. However, its presences is very small or none as the high negative sum of differences express;
- **Privacy** is one dimension that found a good equilibrium between its importance and presence in the new headquarters;
- **View to the exterior** was one of the biggest differences in the headquarters change. The new headquarters has plenty of light and views to the exterior of the software house. That abundance is well expressed in the sum of differences between the presence and importance.
- **Luminosity** is related with the view to the exterior and with that said, it has similar results
- **Silence** is a dimension that is considered to be extremely important to the innovation process. However, it is a dimension that the new headquarters has to improve.

4.4.2 Team analysis

All the information regarding each team's frequency and predominance of team role and comparison between the team's average score in each team role against the scores Belbin proposed in his book can be found in Appendix H.

The Belbin Self-Perception Inventory was validated by the managers of the software house. From the 35 developers that answered to the Belbin SPI, only 3 developers had a negative feedback from the managers to their SPI test: one developer from Team 1, one developer from Team 3 and one developer from Team 7.

4.4.2.1 Scrum Master

The Scrum Master was submitted to the same process of the the rest of the developers of the software house regarding the Belbin Self-Perception Inventory. However, the Scrum Master's information was not validated by a manager.

The Belbin Self-Perception Inventory described the Scrum Master's team role as: **Very High** Implementer profile predominance, **High** Sharp profile predominance and **Very High** Resource Investigator predominance.

The developments teams are still in the very beginning of the learning curve of the Scrum Methodology and the relation that they have with the Scrum Master as not always been tremendously positive.

A Scrum Master's predominant team roles should be, according to literature exposed in the State of the Art chapter, Co-ordinator and Team Worker. One of the software house's Scrum Master does not have those predominant team roles and in that may reside the explanation for the tough relationship between the development teams and the Scrum Master but is someone who is beginning of the learning curve of the task of Scrum Master.

4.4.2.2 Team 1

Team 1 has a good balance of team roles according to the Belbin Team Role Theory. The Monitor-Evaluator and the Shaper are the only team roles that are not predominant in any developer. The average score of the team is higher than the Belbin Score in all team roles expect the Shaper, Implementer and Monitor Evaluator.

The Product Owner has a high predominance of the correct team roles according to the already exposed literature.

Taking into account the manager's evaluation according to the new performance management system, the team has a Innovation grade of 3.33 and and a Leadership grade of 3. The slightly above expectations evaluation is connected and correlated with the good score that the team had in the Plant and Resource Investigator team roles.

Concerning possible adjustments, it is considered that that is not truly necessary in order to boost the innovation process. However, if a recruitment process is initiated, the new comer should be a Shaper or a Monitor-Evaluator.

4.4.2.3 Team 2

Team 2 has a pretty high dominance of the Implementer and Completer-Finisher team roles. However, the roles directly related with Innovation, Plant and Resource Investigator, are not predominant at all and that has a tremendous impact in the team's performance regarding the innovation process. Besides that, the Shaper team role is missing too. Only the Co-ordinator, Implementer and Completer- Finisher team roles have higher average scores than the one presented by Belbin.

There is no developer of this team that is a predominant Plant or Resource Investigator team role. The team has a Innovation grade of 2 and a Leadership grade of 2.33. This is positively correlated with the absence of team roles directly connected with the innovation process.

In order to obtain better outcomes in the innovation process, it is essential to adjust the balance of the team roles by recruiting a Plant or a Resource Investigator or my selecting a developer of the software house that already has those predominant team roles.

4.4.2.4 Team 3

Team 3 has a decent set of team roles that can be associated to its developers. Co-ordinator, Team Worker, Implementer and especially Resource Investigator are the predominant team roles of the team. However, it is important to state the absence of a Shaper, Completer-Finisher, Plant and Monitor-Evaluator. Co-ordinator, Team Worker, Resource Investigator and Implementer have significantly higher average scores than the ones defended by Belbin.

The Product Owner of this team has two important predominant team roles in order to successfully perform its task: Co-ordinator and Resource Investigator.

This team had a 2.66 grade in Innovation and a 2.66 grade in Leadership. However, it is important to analyze that, concerning the Innovation grade, the final result is highly influenced by a specific grade of one of the developers (lowest grade possible). Next team member should be a Completer-Finisher.

4.4.2.5 Team 4

This is a small team and with that said, it is easy to understand that it is hard to have covered all the team roles of Belbin Team Role Theory. This team has a predominance of especially two team roles: Co-ordinator and Implementer. Plant, Shaper and Team Worker have average scores that are in need for attention due to how small they are.

The team had a innovation grade of 1.33 and a Leadership grade of 2. The absence of Resource Investigators and Plants are a direct cause for this poor results in the innovation process.

Product Owner has a good diversity of predominant team roles that are directly associated with having a good performance as a Product Owner in the Scrum Methodology such as Monitor Evaluator, Co-ordinator, Shaper and Implementer.

The next person to join the team must be someone that boosts the innovation process and that is able and prone to generate ideas from within the team as a Plant.

4.4.2.6 Team 5

Team 5 has a balanced performance in almost all the team roles profiles except for the Co-ordinator and Implementer profiles that are extremely predominant in this team.

This team had exceptional results in the Co-ordinator and Implementer team role profiles in comparison with the scores determined by Belbin. The only negative result was verified in the Team Worker profile.

Product Owner does not have good results in the most important team roles for his task: his results in Monitor-Evaluator and Completer Finisher are extremely low.

The team had a Innovation grade of 2.33 and a Leadership grade of 2.33. The Innovation grade is understandable as the score for Resource Investigator is similar to the Belbin Score. A higher grade in Leadership could be expected taking into account the really high score in the Co-ordinator profile but the team had a poor result in the Shaper team role profile.

A good addition to the team would be either someone who concerns about the team members and the relations that exists in a team like a Team Worker or someone who has more harsh leadership skills in order to force the team members to achieve the initial goals like a Shaper.

4.4.2.7 Team 6

Team 6 is one of the biggest teams of the software house and has a pretty good balance of different team roles. The team had exceptional results in the Resource Investigator, Implementer and MonitorEvaluator team role profiles. In the other end, the team has bad results in the Shaper and Team Worker team role profiles.

The team has a Innovation grade of 2 and a Leadership grade of 2. These results were the expected one since the team had results extremely similar to the Belbin Scores in the Innovation profiles (Plant and Resource Investigator) and in the Leadership profiles(Co-ordinator and Shaper).

The Product Owner showed average scores in the most important team roles for his task in the team (Monitor Evaluator and Completer Finisher) and a good result in a less important team role necessary to perform well the duties of a Product Owner (Co-ordinator).

A good addition to the team would be either someone who concerns about the team members and the relations that exists in a team like a Team Worker or someone who has more harsh leadership skills in order to force the team members to achieve the initial goals like a Shaper.

4.4.2.8 Team 7

Similarly to Team 6, Team 7 is one of the biggest teams in the company and it has a good balance of Belbin team roles. Practically all the team roles have scores similar to the Belbin scores except for the Shaper and Plant team role profiles.

The team had low grades regarding Innovation and Leadership mainly because the software module that was developed by the team suffered from reliability issues and that may affected the general grades given by the manager to the team. The team had a 1.25 grade in both Innovation and Leadership. The two team roles that have low scores are directly related to Innovation and Leadership and that could be a reasonable explanation to the results.

The Product Owner has average results in the most important team role profiles for her task (Monitor Evaluator and Completer Finisher) and really good result in a less important team role (Co-ordinator).

A good addition to the team would be either someone who concerns about the team members and the relations that exists in a team like a Team Worker or someone who has more harsh leadership skills in order to force the team members to achieve the initial goals like a Shaper.

4.4.2.9 Team 8

Team 8 is a team still in the Norming stage of group development and it has a good variety of team roles in the team. However, the Plant team role profile that is essential for the innovation process has a quite low result in comparison to the Belbin Scores. The team has average scores in evert team role similar to the Belbin scores except for the Shaper and Plant team role profiles.

The team has a 2.5 grade of Innovation and 2.25 grade of Leadership that correspond to the expect results taking into account the balance of the team roles.

Similarly to Team 6 and Team 7, a good addition to the team would be either someone who concerns about the team members and the relations that exists in a team like a Team Worker or someone who has more harsh leadership skills in order to force the team members to achieve the initial goals like a Shaper.

4.4.2.10 Team 9

Team 9 is one of the teams of the software house that are already working together for a considerable amount of time. It is already in the Performing stage of the Tuckamn's stages of group development. The team has excellent average results in almost every team role profile except for the ones related with Innovation.

The team has a average grade of 1.75 in Innovation and 1.75 in Leadership. The poor results were expected taking into account the balance of team role profiles of the team.

Product Owner has a good diversity of predominant team roles that are directly associated with having a good performance as a Product Owner in the Scrum Methodology such as Monitor-Evaluator, Co-ordinator, Shaper and Implementer.

The next person to join the team must be someone that boosts the innovation process and that is able and prone to generate ideas from within the team as a Plant.

4.4.2.11 Team 10

Similarly to Team 9, Team 10 is working together for quite some time now and is one of the teams that already has an internal network of relationships that turn out to be essential for the success of any team.

The team has a good balance of team role profiles. The only team role profile which scores is significantly lower than the one Belbin proposed was the Shaper team role profile.

The team has a average grade of 2.0 in Innovation and 1.4 in Leadership. The low result in the Leadership evaluation is connected to the low score of the Team in a team role related to Leadership (Shaper).

Before Team Building		After Team Building	
Team Member	IWB value	Team Member	IWB value
Team 7 A	9,5	Team 7 A	12
Team 7 B	7,5	Team 7 B	8
Team 7 C	10	Team 7 C	11,5
Team 7 D	10,5	Team 7 D	11
Team 7 E	10	Team 7 E	9,5
Team 10 A	9,5	Team 10 A	11
Team 10 B	15	Team 10 B	13
Team 10 C	12,25	Team 10 C	12
Team 10 D	10	Team 10 D	11,5
Team 10 E	6,5	Team 10 E	7,5
Team 8 A	12,5	Team 8 A	12,5
Team 8 B	11,5	Team 8 B	12
Team 8 C	18,5	Team 8 C	13,5
Team 8 D	9	Team 8 D	10

Figure 4.3: Innovative work behaviors results

In order to denote in the team attitudes and behaviors of a strong leadership that force the other team mates to work and deliver good results, a Shaper should be the next addition to the team.

4.4.3 Analysis of the impact of team building activities

The impact of team building activities had 3 teams as participants of the study. The short version of the Team Climate Inventory (Cronbach's alpha = 0.904 which indicates a really strong internal reliability) and the questionnaire of Innovative Work Behaviors were used as measurements of the impact of team building activities on the innovative work behaviors demonstrated by the developers and on the team's social climate for innovation.

The teams selected for the study were the following: Team 7, Team 8 and Team 10. Team 8 was involved in other innovation boosting activities such as brainstorming reunions and that could influenced their result in the TCI and IWB.

Before Team Building		After Team Building	
Team Member	TCI value	Team Member	TCI value
Team 7 A	9	Team 7 A	21
Team 7 B	1	Team 7 B	20
Team 7 C	19	Team 7 C	28
Team 7 D	18	Team 7 D	22
Team 7 E	30	Team 7 E	33
Team 10 A	13	Team 10 A	12
Team 10 B	18	Team 10 B	19
Team 10 C	16	Team 10 C	18
Team 10 D	14	Team 10 D	16
Team 10 E	11	Team 10 E	11
Team 8 A	14	Team 8 A	15
Team 8 B	17	Team 8 B	18
Team 8 C	24	Team 8 C	23
Team 8 D	4	Team 8 D	11

Figure 4.4: Team Climate Inventory results

The results of the 2 rounds of tests of the questionnaire related to Innovative Work Behaviors can be seen in Figure 4.3 and the results of the 2 rounds of the questionnaire made with the Team

Climate Inventory can be seen in Figure 4.4.

In order to test the hypothesis that were described above in this chapter, it was used the two sample t-Student test with one tail assuming unequal variances. The two samples of each test are related with results obtained from the TCI and IWB before and after the team building activities.

4.4.3.1 Impact on Social Climate for Innovation

The results of the two rounds of tests can be seen in Figure 4.4. These are the two samples that were used for testing the hypothesis that the team building activities have a positive impact on the Team Climate Inventory score, which means that team building activities have a positive impact on the social climate for innovations of the teams. The objective of this test is to prove that the null hypothesis is false which leads to the reasonable assumption that the alternative hypothesis is true. These tests were ran using the the Analysis Toolpak for the Microsoft Excel 2013.

	Before Team Building	After Team Building
Average	**14,85714286**	**19,0714286**
Variance	55,36263736	39,3021978
Number of Observations	14	14
gl	25	
Stat t	-1,62066649	
P(T<=t) one tail	**0,058817916**	
t critical one tail	1,316345073	

Figure 4.5: Team Climate Inventory t-Student test results

A paired t-test was performed to determine if team building activities have an impact in the social climate for innovation in a team. The one tail $p - value \simeq 0.06$ means that each time we select 100 developers at random and compute the sample mean of the Team Climate Inventory then 6 times out of 100 we can expect to see the same results with or without team building activities. Picking a p-value cutoff of $pvalue = 0.06$, it is significant to say that the alternative hypothesis is strong enough to be supported and that the null hypothesis can be rejected.

In conclusion, it can be stated that the hypothesis of team building activities have an impact on the social climate of a team for innovation is strong enough to be supported

4.4.4 Impact on Innovative Work Behaviors

The results of the two rounds of tests can be seen in Figure 4.3. These are the two samples that were used for testing the hypothesis that the team building activities have a positive impact on the

Innovative Work Behaviors score, which means that team building activities have a positive impact on the daily behaviors that are shown by the developers while they perform their daily routines.

	Before Team Building	After Team Building
Average	**10,98077**	**11**
Variance	9,858974	3,291666667
Number of Observation	13	13
Stat t	-0,01912	
P(T<=t) one tail	**0,492472**	
t critical one tail	1,729133	

Figure 4.6: Innovative Work Behaviors t-Student test results

A paired t-test was performed to determine if team building activities have an impact in the the frequency of the innovative work behaviors of the developers of the software house. The one tail $p-value = 0.49$ means that each time we select 100 developers at random and compute the sample mean of the Innovative Work Behaviors then 49 times out of 100 we can expect to see the same results with or without team building activities. Picking a p-value cutoff of $pvalue = 0.06$, it is significant to say that the null hypothesis cannot be rejected and that the team building activites do not have a significant impact on the frequency of the innovative work behaviors of the developers of the software house.

Chapter 5

Conclusions and Future Work

In this chapter, it is presented a summary of the work that was done during the the six months of work. Furthermore, an analysis of the goals that were reached/accomplished versus the ones that were not possible to reach is made.

Finally, it is described a list of suggestions for future work and possible improvements to the work that was done.

5.1 Goal satisfaction

Taking into account that the main goal of this work was to study the impact of physical and social climate in the innovation process and capability of a software house and its respective development teams, the original big goal was divided into two smaller goals:

- With regard to the impact of the physical environment on the innovation process of a software house, it was made a comparative analysis of a headquarters change. It was analyzed the various dimensions of the physical workplace that affect the innovation capability of the development teams in the old and new headquarters. Regarding the old headquarters, a list of defects and negative characteristics of the office environment related to the innovation process was presented and analyzed. Respecting the new headquarters and taking into account that the questionnaire done to the development teams was made just a week and a half after the change of headquarters, a comparative analysis of the importance that the developers give to some aspects that have an impact on the innovation process and the presence of those aspects was made and conclusions to improve the new headquarters were taken;

- Concerning the impact of the social environment on the innovation process, two different approaches were taken. One approach analyzed the impact of team building activities and the other inspected the balance of team roles in each team. With that separation several conclusions were taken:

- There is a positive correlation between the success of innovation process and the presence of Belbin team roles profiles connected to innovation like Plant or Resource Investigator;
- Team building activities with the objective of improving team cohesiveness and team spirit and other dimensions related to innovation success have a positive impact in the team climate for innovation;
- Team Building activities with the objective of improving team cohesiveness and team spirit and other dimensions related to innovation success do not have a significant impact in the frequency of innovative work behaviors of the developers of a software house.
- According to the team role balance of each team and the evaluation of managers, a list of recommendations to possible future adjustments and recruitments was elaborated in order to boost the innovation process of the software house.

5.2 Future work and possible improvements

Although the organization that was used to perform a case study of the impact of team building activities on the social climate for innovation and on frequency of innovative work behaviors has a quite significant size , the number of observations for hypothesis testing and the availability of certain resources was quite scarce. With this in mind, several suggestions can be made in order to improve the quality and reliability of this kind of study:

- Use a more reliable test that assess the team climate for creativity and innovation like KEYS;
- Choose another way to assess the frequency of innovative work behaviors;
- Perform the full Belbin Self-Perception Inventory with the Observer's Assessment by a fully qualified employee of the Belbin Company;
- Perform the study with a larger sample of development teams.

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Appendix A

Team Building Activities

Semana 1

Nome da Actividade: Consultants

Objectivos:

- Melhorar índices de teamwork
- Gerar ideias criativas que possam solucionar problemas do trabalho diário
- Melhorar comunicação dentro da equipa
- Perceber o quão valioso pode ser o input dos outros
- Perceber como pode ser melhorar o processo de inovação da equipa

Materiais necessários:

- Papel e caneta para cada participante

Preparação

- Cada membro da equipa escreve no seu papel um problema ou preocupação que ele tem durante o seu trabalho (2 minutos);
- Cada membro da equipa passa o seu papel para o colega que estiver à sua esquerda;
- Cada membro da equipa tem 1 minuto para ler o problema que está à sua frente e escrever um conselho importante;
- Passar os papéis novamente até chegar ao dono do papel;

Orientações

- Encorajar conselhos parciais! Escrita de algumas palavras de incentivo ou ajuda podem ajudar outro colega a escrever um conselho

- O problema pode ser de várias ordens: dificuldades técnicas, de relacionamento com colegas/líderes...
- Exemplo de problema (Tenho dificuldade em manter o contacto visual quando estou a dar feedback negativo; Problemas com alguma parte da tecnologia; Problemas com o processo; Problemas com pedir ajuda a um colega...); Exemplo de soluções (Praticar ao espelho; Role-playing com um amigo; Ter a atenção de não dar feedback destrutivo através da técnica da sandwich; Olha como o João dá feedback!)
- O conselho não precisa de ser completo ou revolucionário. Normalmente a 1ª coisa que vem à cabeça é um conselho importante.

Debrief- Perguntas a fazer

- Quantos de vocês arranjaram ideias que vos possam ajudar no vosso trabalho diário?
- Como é que se sentiram no papel de conselheiros? (Não quis impor nenhuma solução; Honrado e respeitado; Pressionado para surgir com um conselho fantástico)
- Porque é que não solicitamos mais frequentemente a ajuda dos outros? (Não queria impor aos outros ter de arranjar uma solução; Não confio nos outros para terem alguma forma de solucionar o problema; Acho que temos de arranjar soluções para os nossos problemas)
- Que implicações este tipo de abertura tem no nosso trabalho diário?
- Como é que o processo de inovação pode ser melhorado?

Semana 2
Nome da Actividade: Puzzled
Objectivo da dinâmica:

- Melhorar a colaboração entre os membros da equipa
- Melhorar índices de teamwork;
- Passar mensagem da importância do empowerment e de como a equipa tem de resolver os seus próprios problemas;
- Cooperação para além de limites perceptíveis pelos membros da equipa é importante e benéfica.

Materiais necessários:

- Puzzle por equipa pequeno (20-50 peças)
- Saco para dividir as peças por grupo

Preparação

- Cada puzzle em cada saco;
- Trocar 3/4 peças por saco com peças de outros puzzles;
- 1 saco por grupo;
- Divisão da equipa de trabalho em grupos de dois;
- Distribuir os sacos pelos grupos;
- Não se informa que os sacos foram adulterados;
- Dizer aos grupos que o objectivo da tarefa é montar o puzzle em menos de 5 minutos;
- Começar a tarefa.

Orientações

- Não dar ajuda. Se for pedida, apenas encorajar as equipas a usar os recursos que têm disponíveis para cumprir com o objectivo ao dizer que eles têm acesso a todas as peças para cumprir com o objectivo;
- Se for pedido para trabalhar com outros grupos, adoptar postura evasiva dizendo que a equipa sabe qual é o objectivo e que só tem de fazer o acharem que é necessário para cumprir com o objectivo;
- Não fazer comentários que possa indicar que estão numa competição.

Debrief-Perguntas a fazer

- Que suposições fizeram no início da actividade?
- Porque é que sentiram que estavam numa competição?
- Em que esta actividade é similar ao trabalho diário? (Vemos tudo como uma competição...; Pedimos ajuda quando somos capazes de resolver o nosso problema sozinho?)
- Como podemos melhorar o nosso trabalho enquanto equipa?

Semana 3 e 4
Nome da Actividade: Team Effectiveness Exercise
Objectivo da dinâmica:

- Melhorar a colaboração entre os membros da equipa
- Melhorar índices de coesão dentro da equipa
- Aumentar os níveis de responsabilidade de uma equipa dentro da equipa sem envolver o líder
- Passar para a equipa a noção de que pressão e possível desgosto do colega é pior que uma punição do líder

Materiais necessários:

- Papel e caneta para cada participante
- 90 minutos

Orientações

1. Todos os elementos da equipa têm de responder a duas questões sobre os colegas de equipa:
   (a) Qual é a qualidade comportamental mais importante da pessoa que mais contribui para o sucesso da equipa na inovação?
   (b) Qual é a característica comportamental mais significativa da pessoa que mais diminui a capacidade de sucesso da equipa na inovação?
2. Todos os elementos têm de escrever as respostas para que haja um compromisso com as respostas dadas
3. Começando pelo líder da equipa, toda a gente lê os pontos positivos.
4. Pergunta-se ao líder da equipa para responder ao que foi dito pelos membros da equipa (“Está surpreendido?” ou “Alguma questão que é necessário esclarecer?”)
5. Continuando centrado no líder, fazer com que todos os membros da equipa leiam as respostas negativas.
6. Continuar esta sequência para toda a gente

Debrief

- Cada membro deverá focar-se em dois aspectos que foram mencionados e que serão alvo de trabalho individual.
- Na sessão seguinte de teambuilding, fazer um balanço das mudanças verificadas.

Appendix B

Repertoire of photos of the former headquarters

Figure B.1: Former auditorium

Figure B.2: Community area for the leisure of the developers

Figure B.3: Area reserved for the meals of the staff

Figure B.4: Meeting place where Scrum meeting occur

Figure B.5: One of the development rooms

Figure B.6: Another development room

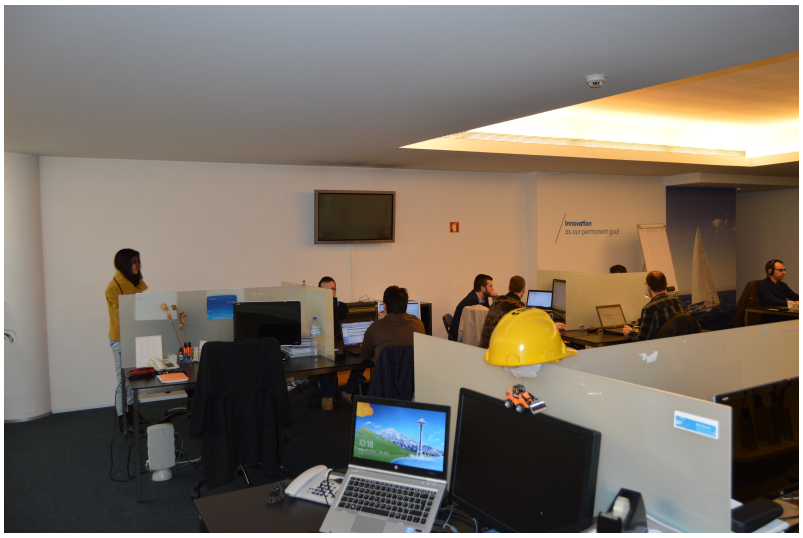

Figure B.7: Other development room

Appendix C

Repertoire of photos of the new headquarters

Figure C.1: Meeting room

Figure C.2: Meeting place for leisure and Scrum meetings

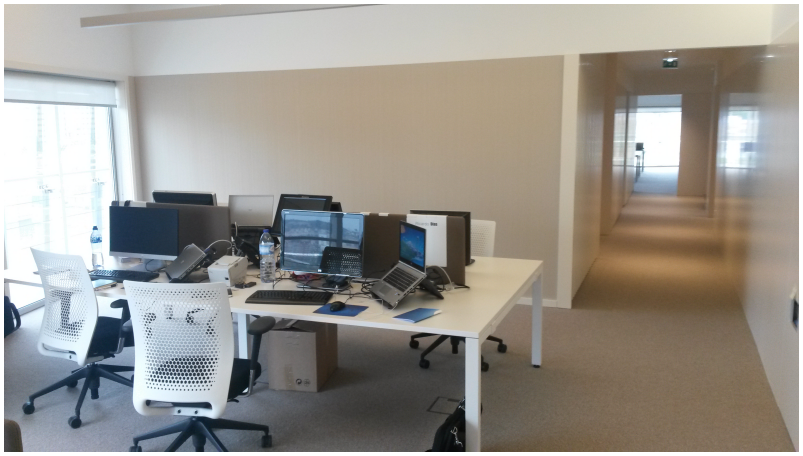

Figure C.3: Development room

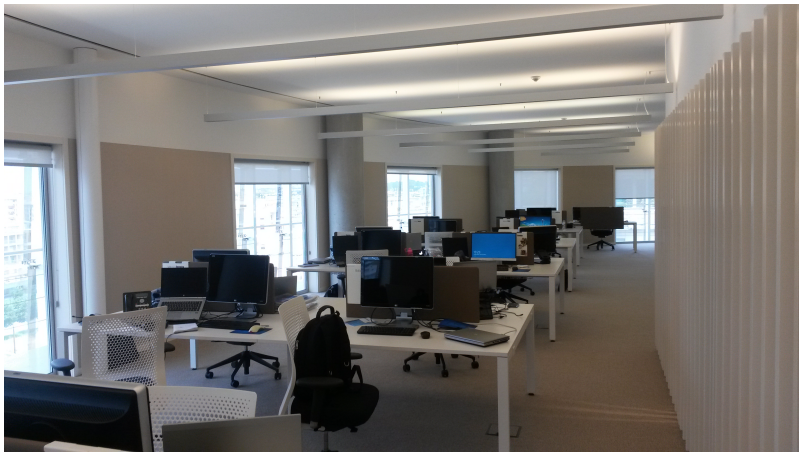

Figure C.4: Other development room

Figure C.5: Another development room

Repertoire of photos of the new headquarters

Appendix D

Belbin Self-Perception Inventory

Belbin- SPI

Questionário

Este é um questionário que pretende rotular os comportamentos que existem no dia-a-dia na PRIMAVERA. Para cada pergunta, primeiro leia todas as frases e depois distribua dez pontos pelas diversas afirmações da secção consoante se se ajusta ou não às atitudes que tem no trabalho(0 pontos equivale a uma frase que não é adequada e 10 a uma frase que ilustra perfeitamente a nossa atitude). Este questionário não tem como objectivo fazer qualquer tipo de avaliação. Os pontos podem ser atribuídos de várias maneiras por cada pergunta: podem existir casos extremos onde uma afirmação recebe dez pontos ou poderá acontecer uma distribuição mais equilibrada do valor atribuído a cada frase. Resumindo, a soma de todos os pontos atribuídos às frases de cada pergunta tem de ser igual a 10! Por favor, não atribua cotação máxima a uma frase em mais de 3 perguntas pois resulta na invalidez do questionário.
Obrigado pela ajuda e tempo despendido.

***1. Nome:**

***2. Marque com um círculo a sua equipa:**

- EAM
- RH
- FISC
- COP
- L&T
- AP
- IND
- BS
- SMK
- FIN

3. Acredito que consigo fazer contribuições positivas para a minha equipa porque:

Acho que posso rapidamente ver e tirar vantagem de novas oportunidades	
Sinto-me bem ao trabalhar com pessoas muito diferentes de mim	
Gerar ideias novas é um dos meus dons naturais	
Faço com que as pessoas falem quando percebem que podem contribuir com algo positivo para a equipa	
A minha capacidade de concluir o trabalho depende muito da eficácia do meu trabalho pessoal	
Estou preparado para a falta de popularidade se isso levar a resultados que valham a pena	
Percebo rápido o que pode dar certo em situações com a qual estou familiarizado	
Posso oferecer opiniões equilibradas para agir sem viés ou preconceito	

4. Se eu tiver uma dificuldade no trabalho de grupo, esta pode dever-se a:

Não me sentir confortável quando as reuniões não são bem coordenadas,administradas e estruturadas	
Gosto de dar tempo de antena a pessoas cujas ideias e opiniões ainda não tenham sido ouvidas	

Tenho a tendência de fornecer muito input sempre que aparece uma nova ideia

Devido à minha objectividade, tenho dificuldade em escutar e aderir a ideias de colegas de equipa

Por vezes, pareço autoritário e demasiado assertivo quando é necessário conseguir que algo seja feito

Acho difícil liderar a equipa pois sou demasiado sensível e compreensível com a atmosfera da equipa

Tenho tendência de me perder com ideias novas e consequentemente perco atenção do que está a acontecer no momento

Os meus colegas de equipa vêem-me como alguém desnecessariamente preocupado com detalhes e com a possibilidade de o projeto não correr como previsto

5. Quando estou envolvido num projeto com outras pessoas:

Tenho a capacidade de as influenciar sem as pressionar

Permaneço vigilante para evitar que omissões ou erros por descuido sejam cometidos

Estou pronto para pressionar para ter a certeza que as reuniões não percam o seu propósito ou sejam significado de tempo perdido

Podem contar comigo para contribuir com ideias originais

Estou sempre pronto para apoiar boas sugestões em favor do interesse comum

Sou interessado em procurar as ultimas novidades em termos de tecnologias e metodologias de desenvolvimento

Acredito que a minha capacidade para analisar calmamente é apreciada pelos meus colegas

Podem contar comigo para verificar que todo o trabalho essencial é organizado

6. A minha abordagem para trabalhar em equipa é caracterizada por :

Demonstro interesse em conhecer melhor os meus colegas de equipa

Não desisto de desafiar o ponto de vista dos outros ou defender um ponto de vista meu mesmo que não seja o mais adequado à situação

Encontro normalmente uma linha de raciocínio para refutar propostas inconsistentes

Foco-me no meu talento para fazer as coisas funcionarem uma vez que o plano tenha que ser colocado em prática

Tenho a tendência de evitar o óbvio e de produzir algo inesperado

Trago um toque de perfeccionismo em qualquer trabalho em que esteja envolvido

Sinto-me à vontade para utilizar contactos fora da própria equipa para procurar ajudar para o projecto

Sou interessado em todas as visões mas não hesito em chegar a uma conclusão de uma discussão para que uma decisão seja tomada

7. Sinto-me satisfeito no trabalho porque:

Gosto de analisar uma determinada situação e ponderar sobre todas as escolhas possíveis	
Sou interessado em encontrar soluções práticas para os problemas	
Gosto de sentir que apoio e fomento as boas relações de trabalho	
Posso ter uma forte influência nas decisões	
Posso lidar com pessoas que têm algo de novo para oferecer	
Consigo gerar um consenso na equipa para haver uma certa ordem de acções	
Sinto-me bem onde sou capaz de me focalizar exclusivamente numa tarefa	
Estou numa área onde posso dar azo à minha imaginação	

8. Perante uma tarefa difícil com tempo limitado e com necessidade de interagir com pessoas não tão conhecidas:

Sinto vontade em adoptar uma postura evasiva e arranjar uma forma de sair do impasse antes de planear uma linha de acções	
Estaria pronto para trabalhar com a pessoa que apresentasse a abordagem mais positiva	
Tentaria arranjar uma forma de reduzir a complexidade da tarefa envolvendo toda a gente na área onde pudessem contribuir mais para a tarefa	
O meu sentido natural de urgência iria ajudar a garantir que a equipa não falhasse em cumprir o planeado	
Acredito que poderia permanecer tranquilo e manter a minha capacidade de pensar claramente	
Conseguia manter uma estabilidade de objetivos apesar das várias pressões	
Estaria preparado para assumir o papel de líder ao sentir que o grupo não estava a progredir da forma esperada	
Tentava abrir um espaço de discussão para estimular novas ideias e desta forma iniciar o desenvolvimento de acções	

9. Em relação a problemas que surgem quando trabalho em equipa:

Demonstro-me impaciente para aqueles que estão a atrasar o grupo de trabalho	
Sou facilmente criticado pelos meus colegas pois sou muito analítico e pouco intuitivo	
O meu sentido perfeccionista pode atrasar o desenvolvimento do projecto da equipa	
Apoio-me demasiado em colegas de equipa para me motivar para concluir o trabalho a ser feito	
Sinto dificuldade em começar a trabalhar sem haver clareza nos objectivos a serem cumpridos	
Tenho dificuldade em explicar e esclarecer alguns pontos de vista complexos que me possam surgir	

Tenho consciência para pedir que sejam atribuídas tarefas a colegas de equipa quando não me sinto preparado para as fazer

Hesito em expressar a minha opinião quando encontro forte oposição dentro da equipa

Concluído

Appendix E

First questionnaire made to the development teams

Questionário Inovação

Editar este formulário

Este questionário tem como objetivo identificar comportamentos e fatores que têm influência na capacidade de inovação.
A confidencialidade dos dados obtidos em todas as respostas é totalmente garantida. Os resultados serão utilizados para produzir dados de relevância académica, que nunca serão comunicados nem divulgados.

*Obrigatório

Nome *

Comportamentos de inovação

Esta secção tem como objectivo perceber os comportamentos de inovação que costuma adoptar no seu trabalho diário

Presto atenção a aspetos que não estão diretamente ligados ao meu trabalho diário *

- Nunca
- Raramente
- Frequentemente
- Sempre

Penso em como os produtos e processos poderiam ser melhorados *

- Nunca
- Raramente
- Frequentemente
- Sempre

Pesquiso novos métodos, técnicas e ferramentas para fazer o meu trabalho *

- Nunca
- Raramente
- Frequentemente
- Sempre

Sou capaz de gerar soluções originais para problemas *

- Nunca
- Raramente
- Frequentemente
- Sempre

Identifico novas abordagens para executar as minhas tarefas *

- Nunca
- Raramente

- Frequentemente
- Sempre

Participo em iniciativas de inovação promovidas pela empresa *

- Nunca
- Raramente
- Frequentemente
- Sempre

Apresento ideias inovadoras aos meus superiores hierárquicos *

- Nunca
- Raramente
- Frequentemente
- Sempre

Tento convencer os meus colegas/superiores em como as minhas ideias têm valor *

- Nunca
- Raramente
- Frequentemente
- Sempre

Consigo apresentar corretamente e com entusiasmo o valor das minhas ideias *

- Nunca
- Raramente
- Frequentemente
- Sempre

Transformo ideias inovadoras em protótipos *

- Nunca
- Raramente
- Frequentemente
- Sempre

Contribuo para a implementação de ideias inovadoras *

- Nunca
- Raramente
- Frequentemente
- Sempre

Utilizo tempo pessoal para transformar ideias inovadoras em protótipos *

- Nunca
- Raramente
- Frequentemente
- Sempre

Continuar »

Questionário Inovação

Editar este formulário

*Obrigatório

AMBIENTE FÍSICO E SOCIAL DE DESENVOLVIMENTO

Esta secção tem como objectivo avaliar as várias condicionantes que podem proporcionar ou bloquear

Os objectivos da equipa são claros para mim *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Os objectivos definidos para a equipa são apropriados e utéis *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Estou de acordo com estes objectivos *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Os meus companheiros de equipa estão de acordo com esses objectivos *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Os objectivos definidos para a equipa são alcançáveis e realistas *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo

- Concordo totalmente

Normalmente, dentro da equipa, partilhamos informação e conhecimento em vez de o guardarmos para cada um de nós *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Dentro da equipa, estamos todos com uma atitude de "estamos nisto juntos" *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Dentro da equipa, todos somos influenciados pelos colegas. *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Toda a gente sente-se compreendida e aceite pelos pares *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Quando as coisas não correm bem, tento desculpabilizar-me recorrendo a outros. *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Dentro da equipa, as pessoas são facéis de abordar e amigáveis *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Os meus colegas de equipa apoiam o meu trabalho *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

A minha equipa é aberta e reactiva à mudança *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

Na minha equipa disponibilizamos o tempo necessário para implementar ideias novas *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

Eu e os meus colegas de equipa colaboramos para desenvolver e aplicar novas ideias *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

Os membros da minha equipa partilham recursos e conhecimento para aplicar ideias novas *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

Os meus colegas de equipa partilham ideias utéis e ajudam-me a atingir todo o meu potencial *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

Eu vigio o trabalho dos meus colegas e os meus colegas vigiam o meu de maneira a

manter um nível de trabalho aceitável *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

A equipa avalia continuamente o seu trabalho de maneira a aumentar a sua eficiência *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

Na escolha da solução a adoptar, é procurada a melhor solução que é aceite por todos *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

Como equipa, comunicamos e interagimos frequentemente *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

O meu local de trabalho é facilmente reorganizado para melhorar as minhas condições de trabalho? *

- ○ De maneira nenhuma
- ○ Em alguma medida
- ○ De certa forma
- ○ Com alguma facilidade
- ○ Completamente flexível

O meu local de trabalho é confortável o suficiente para não sentir cansado no final do dia de trabalho? *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

As condições físicas disponíveis no meu trabalho influenciam a minha capacidade de

mostrar novas ideias aos meus colegas e superiores *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

O meu ambiente de trabalho é silencioso *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Mobiliário apropriado e confortável afecta positivamente a minha productividade e capacidade de inovação *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Quais são para si os principais bloqueios à capacidade de inovação da Primavera? *

« Anterior Enviar

Nunca envie palavras-passe através dos Formulários do Google.

First questionnaire made to the development teams

Appendix F

Second questionnaire made to the development teams

Questionário Inovação

Editar este formulário

Este questionário tem como objetivo identificar comportamentos e fatores que têm influência na capacidade de inovação.
A confidencialidade dos dados obtidos em todas as respostas é totalmente garantida. Os resultados serão utilizados para produzir dados de relevância académica, que nunca serão comunicados nem divulgados.

*Obrigatório

Nome *

Comportamentos de inovação

Esta secção tem como objectivo perceber os comportamentos de inovação que costuma adoptar no seu trabalho diário

Presto atenção a aspetos que não estão diretamente ligados ao meu trabalho diário *

- Nunca
- Raramente
- Frequentemente
- Sempre

Penso em como os produtos e processos poderiam ser melhorados *

- Nunca
- Raramente
- Frequentemente
- Sempre

Pesquiso novos métodos, técnicas e ferramentas para fazer o meu trabalho *

- Nunca
- Raramente
- Frequentemente
- Sempre

Sou capaz de gerar soluções originais para problemas *

- Nunca
- Raramente
- Frequentemente
- Sempre

Identifico novas abordagens para executar as minhas tarefas *

- Nunca
- Raramente

- Frequentemente
- Sempre

Participo em iniciativas de inovação promovidas pela empresa *

- Nunca
- Raramente
- Frequentemente
- Sempre

Apresento ideias inovadoras aos meus superiores hierárquicos *

- Nunca
- Raramente
- Frequentemente
- Sempre

Tento convencer os meus colegas/superiores em como as minhas ideias têm valor *

- Nunca
- Raramente
- Frequentemente
- Sempre

Consigo apresentar corretamente e com entusiasmo o valor das minhas ideias *

- Nunca
- Raramente
- Frequentemente
- Sempre

Transformo ideias inovadoras em protótipos *

- Nunca
- Raramente
- Frequentemente
- Sempre

Contribuo para a implementação de ideias inovadoras *

- Nunca
- Raramente
- Frequentemente
- Sempre

Utilizo tempo pessoal para transformar ideias inovadoras em protótipos *

- Nunca
- Raramente
- Frequentemente
- Sempre

Continuar »

Questionário Inovação

Editar este formulário

*Obrigatório

AMBIENTE SOCIAL DE DESENVOLVIMENTO

Esta secção tem como objectivo avaliar as várias condicionantes que podem proporcionar ou bloquear

Os objectivos da equipa são claros para mim *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Os objectivos definidos para a equipa são apropriados e utéis *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Estou de acordo com estes objectivos *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Os meus companheiros de equipa estão de acordo com esses objectivos *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Os objectivos definidos para a equipa são alcançáveis e realistas *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo

- Concordo totalmente

Normalmente, dentro da equipa, partilhamos informação e conhecimento em vez de o guardarmos para cada um de nós *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Dentro da equipa, estamos todos com uma atitude de "estamos nisto juntos" *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Dentro da equipa, todos somos influenciados pelos colegas. *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Toda a gente sente-se compreendida e aceite pelos pares *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Quando as coisas não correm bem, tento desculpabilizar-me recorrendo a outros. *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Dentro da equipa, as pessoas são facéis de abordar e amigáveis *

- Discordo totalmente
- Discordo
- Não concordo nem discordo
- Concordo
- Concordo totalmente

Os meus colegas de equipa apoiam o meu trabalho *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

A minha equipa é aberta e reactiva à mudança *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

Na minha equipa disponibilizamos o tempo necessário para implementar ideias novas *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

Eu e os meus colegas de equipa colaboramos para desenvolver e aplicar novas ideias *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

Os membros da minha equipa partilham recursos e conhecimento para aplicar ideias novas *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

Os meus colegas de equipa partilham ideias utéis e ajudam-me a atingir todo o meu potencial *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

Eu vigio o trabalho dos meus colegas e os meus colegas vigiam o meu de maneira a

manter um nível de trabalho aceitável *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

A equipa avalia continuamente o seu trabalho de maneira a aumentar a sua eficiência *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

Na escolha da solução a adoptar, é procurada a melhor solução que é aceite por todos *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

Como equipa, comunicamos e interagimos frequentemente *

- ○ Discordo totalmente
- ○ Discordo
- ○ Não concordo nem discordo
- ○ Concordo
- ○ Concordo totalmente

Ambiente físico

De seguida, é pedida uma avaliação do espaço físico da nova sede tendo em conta a presença de certos elementos e a importância que esses elementos podem ter no apoio à criatividade e inovação. Avalie cada elemento de 1 a 7: 1 equivale a muito pouco importante/presente e 7 a muito importante/presente

Mobiliário - Importância deste elemento no apoio à inovação

1	2	3	4	5	6	7
○	○	○	○	○	○	○

Mobiliário - Presença deste elemento no apoio à inovação na nova sede

1	2	3	4	5	6	7
○	○	○	○	○	○	○

Plantas - Importância deste elemento no apoio à inovação na nova sede

1 2 3 4 5 6 7

Plantas - Presença deste elemento no apoio à inovação na nova sede

1 2 3 4 5 6 7

Privacidade - Importância deste elemento no apoio à inovação na nova sede

1 2 3 4 5 6 7

Privacidade - Presença deste elemento no apoio à inovação na nova sede

1 2 3 4 5 6 7

Vista para o exterior- Importância deste elemento no apoio à inovação na nova sede

1 2 3 4 5 6 7

Vista para o exterior- Presença deste elemento no apoio à inovação na nova sede

1 2 3 4 5 6 7

Luminosidade - Importância deste elemento no apoio à inovação na nova sede

1 2 3 4 5 6 7

Luminosidade - Presença deste elemento no apoio à inovação na nova sede

1 2 3 4 5 6 7

Silêncio ou sons positivos (música, ausência de barulho) - Importância deste elemento no apoio à inovação na nova sede

1 2 3 4 5 6 7

Silêncio ou sons positivos (música, ausência de barulho) - Presença deste elemento no apoio à inovação na nova sede

1 2 3 4 5 6 7

« Anterior Enviar

Nunca envie palavras-passe através dos Formulários do Google.

Appendix G

Results of the first questionnaire about the physical environment

Results of the first questionnaire about the physical environment

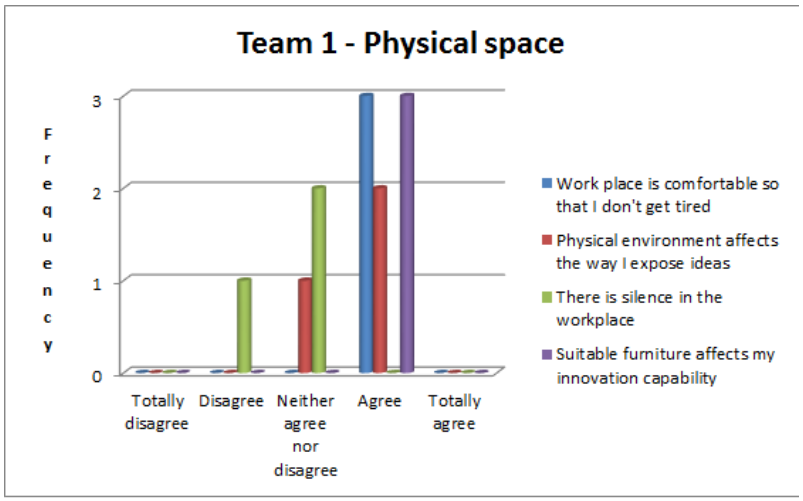

Figure G.1: Team 1 Opinion about the former physical environment

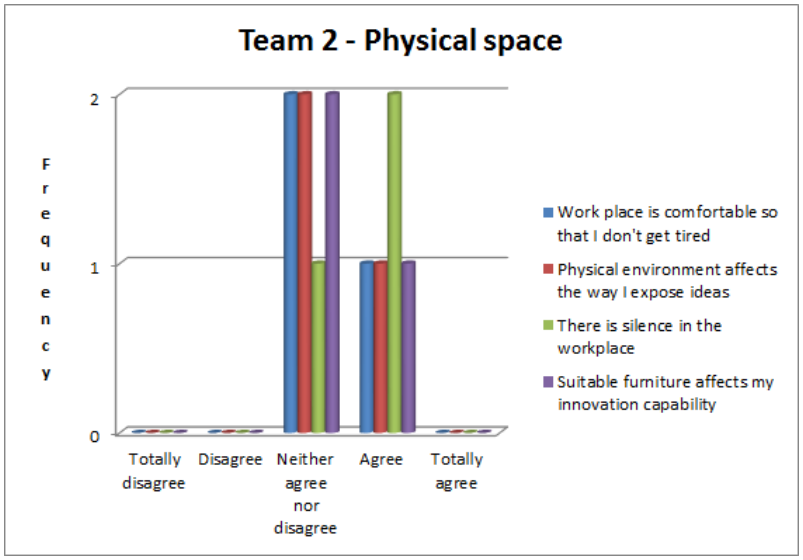

Figure G.2: Team 2 Opinion about the former physical environment

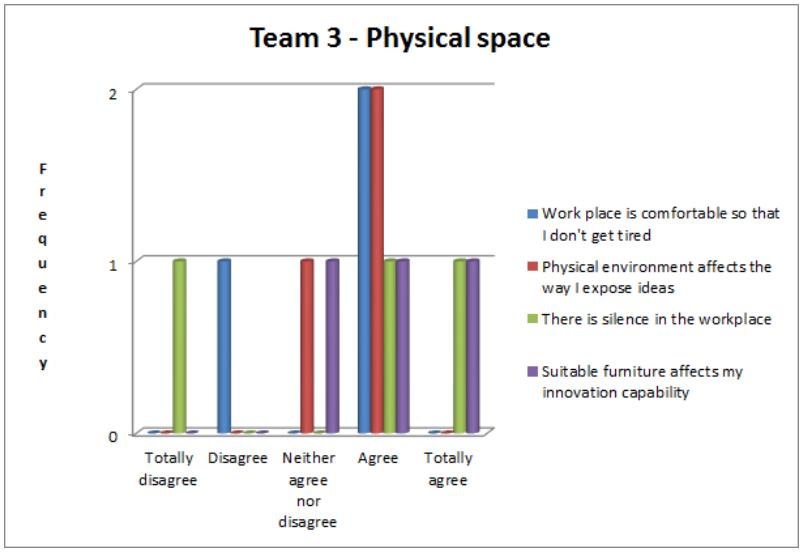

Figure G.3: Team 3 Opinion about the former physical environment

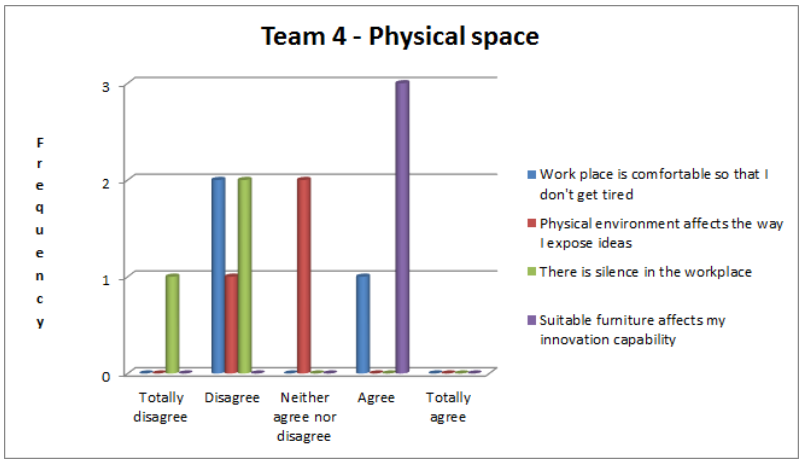

Figure G.4: Team 4 Opinion about the former physical environment

Results of the first questionnaire about the physical environment

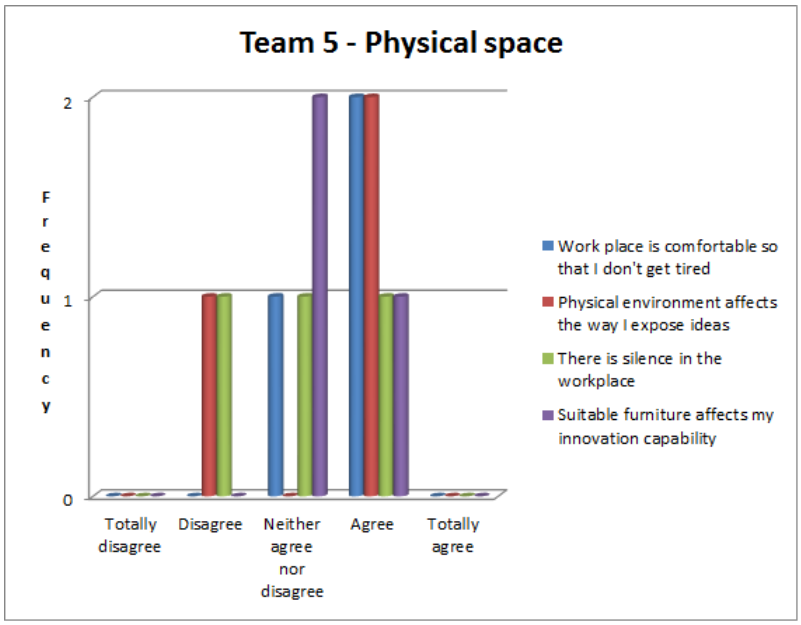

Figure G.5: Team 5 Opinion about the former physical environment

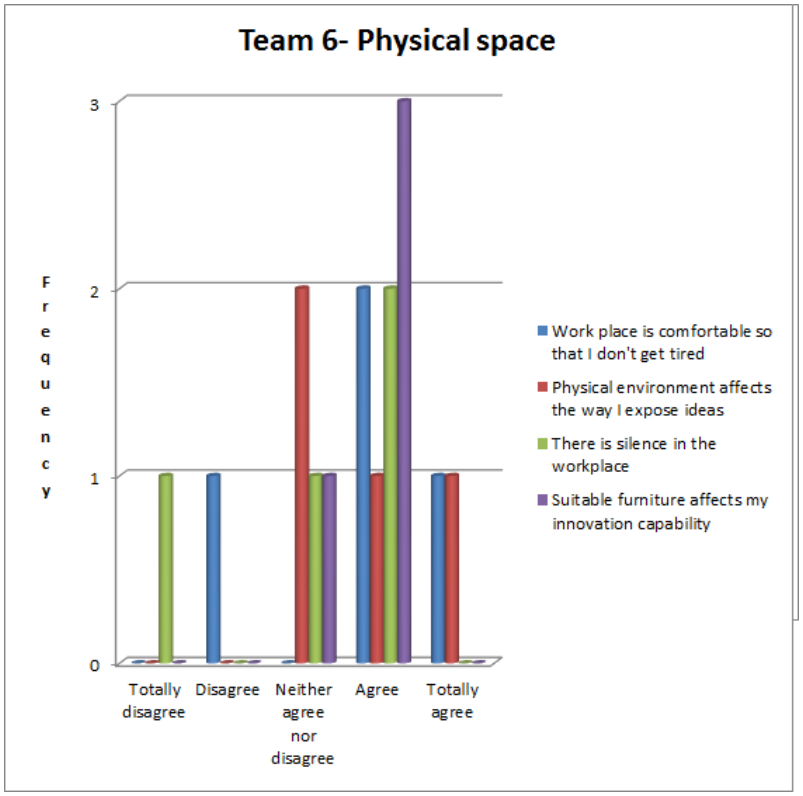

Figure G.6: Team 6 Opinion about the former physical environment

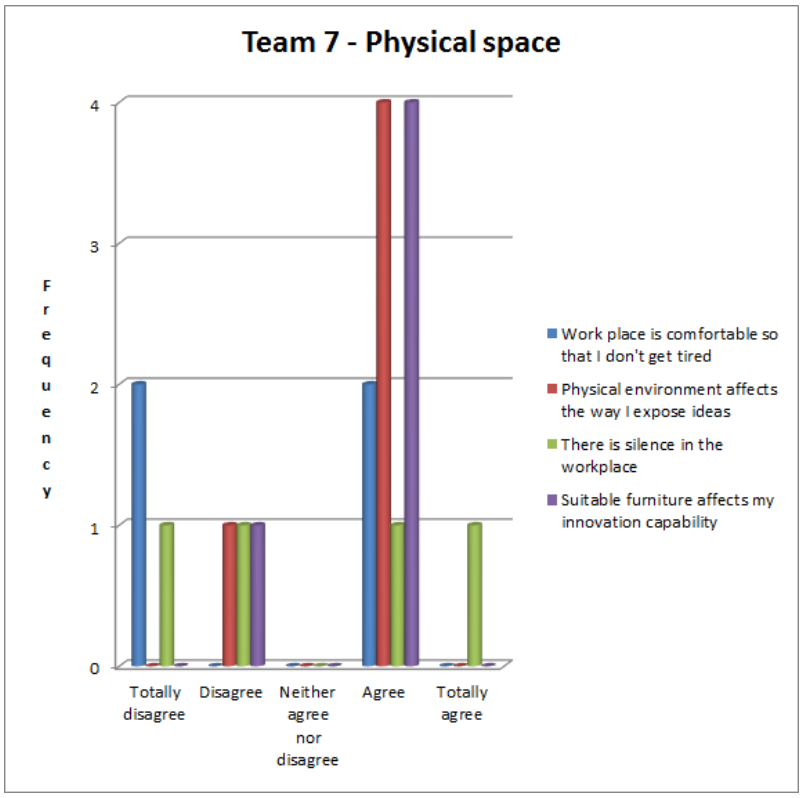

Figure G.7: Team 7 Opinion about the former physical environment

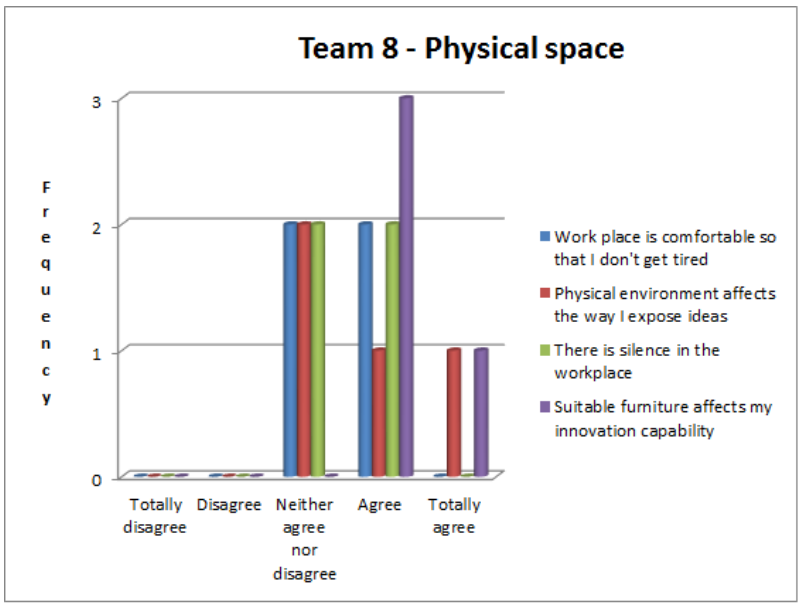

Figure G.8: Team 8 Opinion about the former physical environment

Results of the first questionnaire about the physical environment

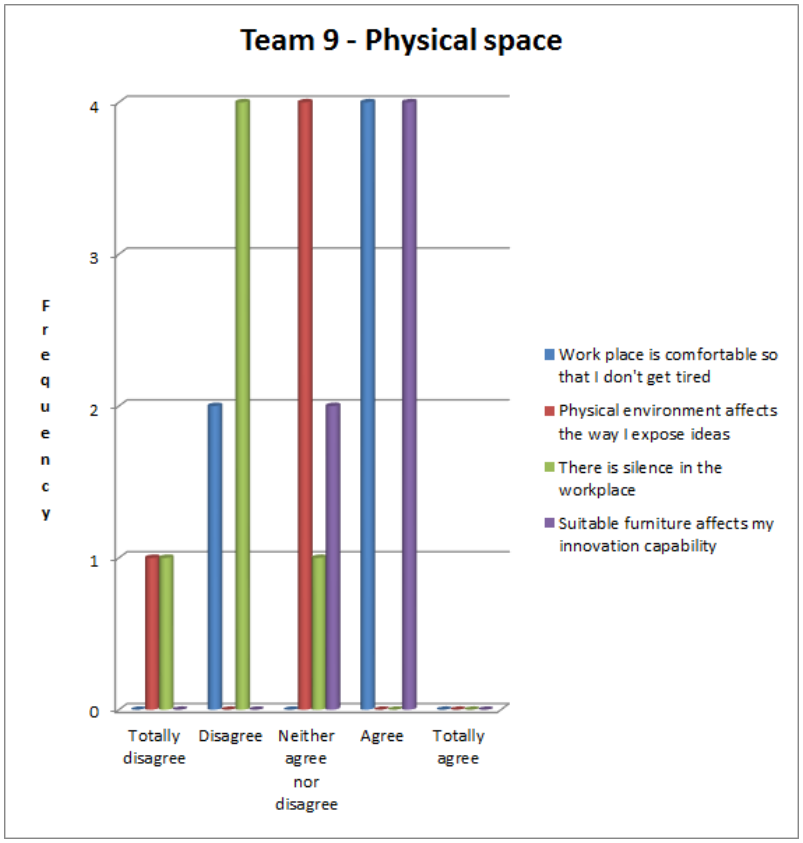

Figure G.9: Team 9 Opinion about the former physical environment

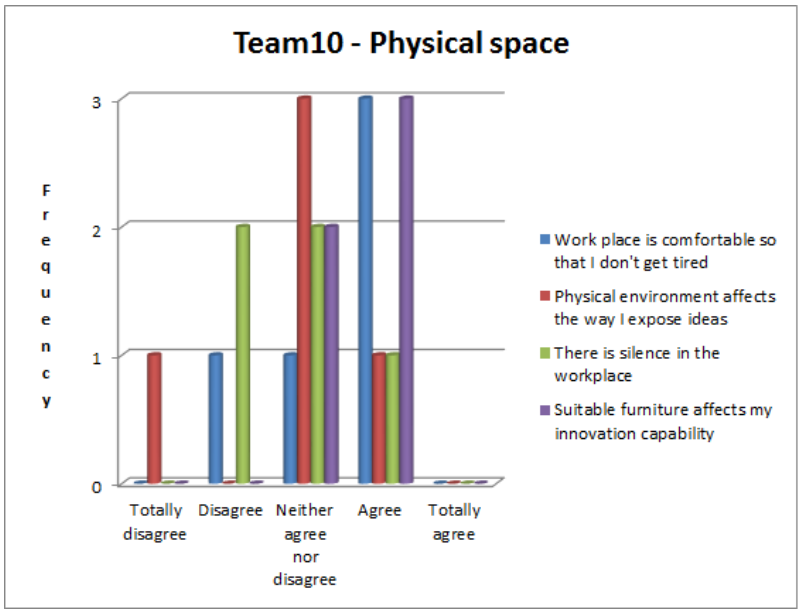

Figure G.10: Team 10 Opinion about the former physical environment

Appendix H

Team analysis

Results						
Belbin Role	Frequency				Average Score	Belbin Score
	L	A	H	VH		
CO	0	1	1	0	10,5	8,8
TW	1	0	0	1	13,5	10,9
RI	0	1	0	1	10,5	7,8
SH	1	1	0	0	4,5	11,6
IMP	1	0	1	0	10,0	10
CF	0	1	1	0	7,0	5,5
PL	0	1	1	0	8,0	7,3
ME	1	1	0	0	6,0	8,2

Table H.1: Team 1 Frequency and predominance of Team Roles

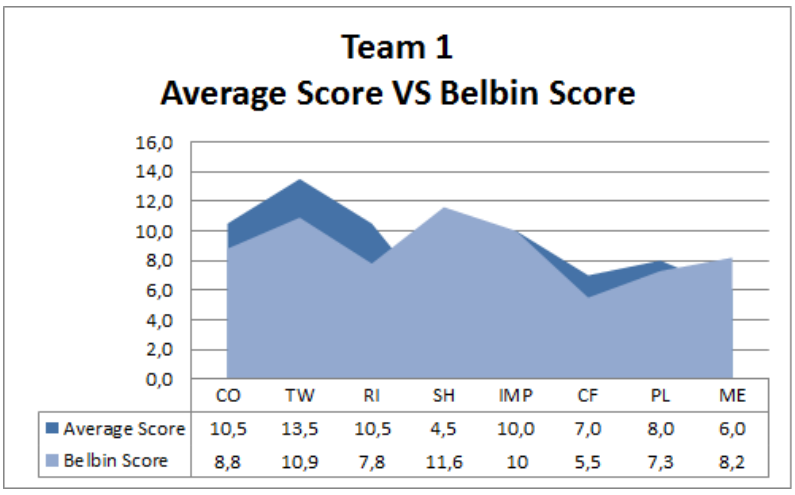

Figure H.1: Team 1 Average Score vs Belbin Score

Results						
Belbin Role	Ocorrência				Average Score	Belbin Score
	L	A	H	VH		
CO	0	1	1	0	10,0	8,8
TW	0	1	1	0	8,5	10,9
RI	2	0	0	0	0,5	7,8
SH	2	0	0	0	0,0	11,6
IMP	0	0	0	2	21,0	10
CF	0	0	1	1	12,0	5,5
PL	1	1	0	0	4,0	7,3
ME	0	1	1	0	10,5	8,2

Table H.2: Team 2 Frequency and predominance of Team Roles

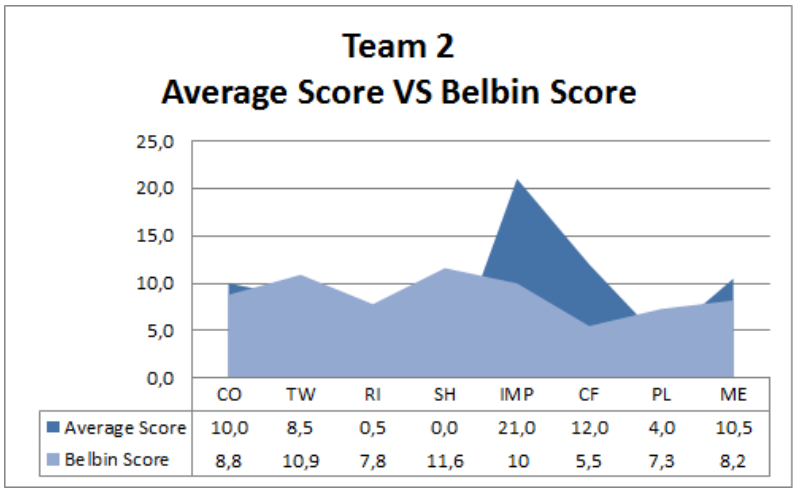

Figure H.2: Team 2 Average Score vs Belbin Score

Results						
Belbin Role	Frequency				Average Score	Belbin Score
	L	A	H	VH		
CO	1	1	0	1	10,7	8,8
TW	1	1	0	1	12,0	10,9
RI	0	0	1	2	13,3	7,8
SH	3	0	0	0	3,7	11,6
IMP	0	1	1	1	15,7	10
CF	0	3	0	0	5,0	5,5
PL	1	2	0	0	4,7	7,3
ME	2	1	0	0	4,7	8,2

Table H.3: Team 3 Frequency and predominance of Team Roles

Results						
Belbin Role	Frequency				Average Score	Belbin Score
	L	A	H	VH		
CO	0	0	1	1	16,5	8,8
TW	1	1	0	0	6,5	10,9
RI	1	0	1	0	6,5	7,8
SH	1	0	1	0	8,0	11,6
IMP	0	0	1	1	16,5	10
CF	1	1	0	0	3,5	5,5
PL	1	1	0	0	2,5	7,3
ME	0	1	1	0	10,0	8,2

Table H.4: Team 4 Frequency and predominance of Team Roles

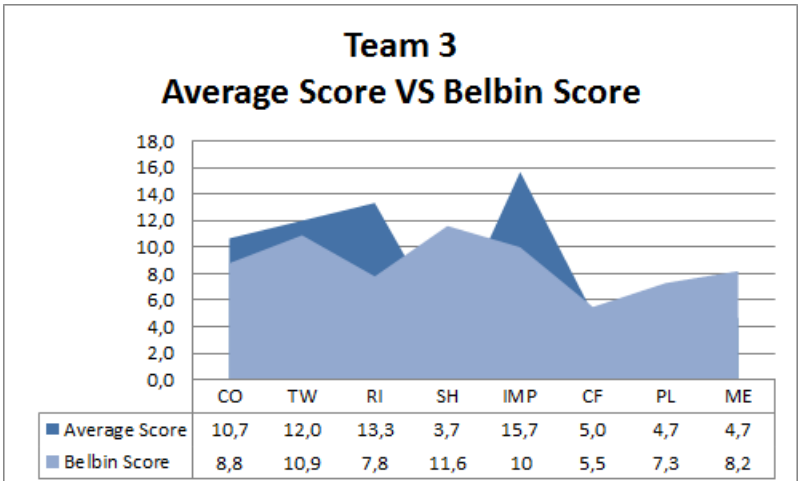

Figure H.3: Team 3 Average Score vs Belbin Score

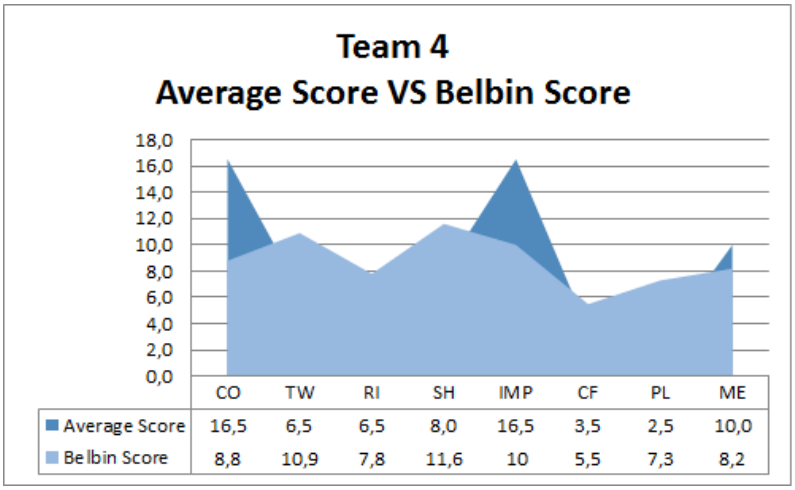

Figure H.4: Team 4 Average Score vs Belbin Score

Results						
Belbin Role	Frequency				Average Score	Belbin Score
	L	A	H	VH		
CO	0	1	2	1	12,0	8,8
TW	2	1	0	1	7,3	10,9
RI	1	3	0	0	7,8	7,8
SH	3	0	1	0	6,0	11,6
IMP	0	1	1	3	17,0	10
CF	1	2	1	0	5,0	5,5
PL	2	0	2	0	6,5	7,3
ME	1	2	1	0	8,5	8,2

Table H.5: Team 5 Frequency and predominance of Team Roles

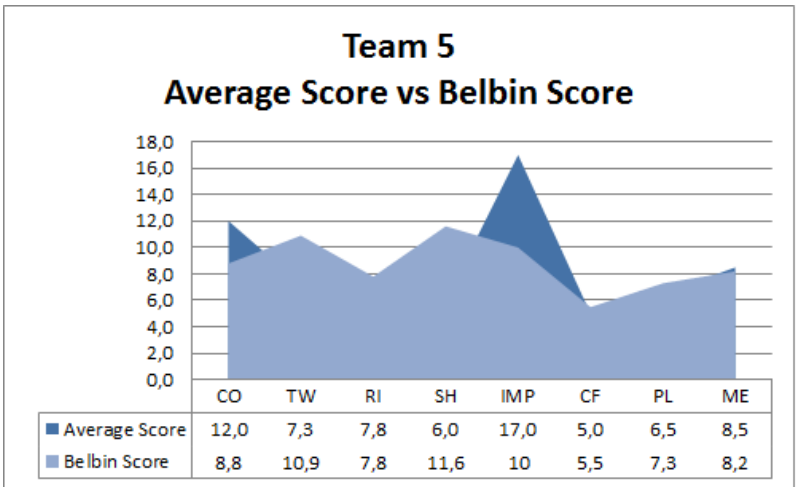

Figure H.5: Team 5 Average Score vs Belbin Score

Resultados						
Papel Belbir	Ocorrência				Average Score	Belbin Score
	L	A	H	VH		
CO	1	0	3	0	8,75	8,8
TW	3	1	0	0	7,5	10,9
RI	0	0	3	1	10,8	7,8
SH	3	1	0	0	5,5	11,6
IMP	0	1	2	1	14,8	10
CF	1	1	2	0	4,5	5,5
PL	0	3	1	0	7,3	7,3
ME	1	2	0	1	11,0	8,2

Table H.6: Team 6 Frequency and predominance of Team Roles

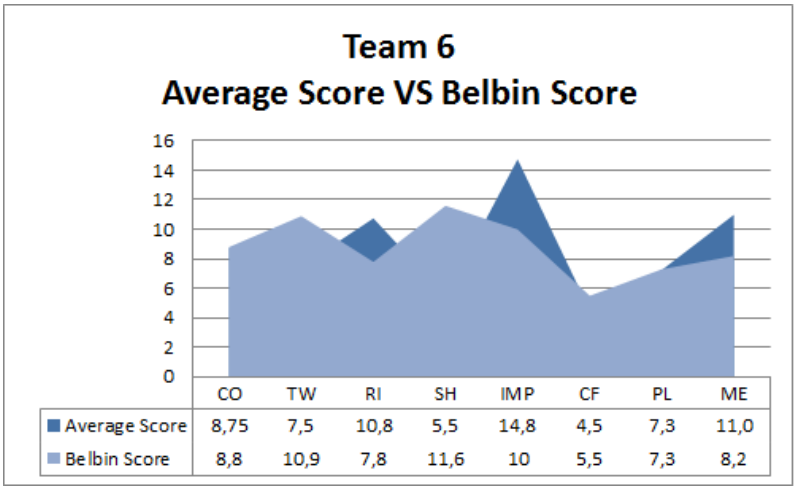

Figure H.6: Team 6 Average Score vs Belbin Score

Results						
Belbin Role	Frequency				Average Score	Belbin Score
	L	A	H	VH		
CO	0	4	0	1	10,8	8,8
TW	1	4	0	0	9,6	10,9
RI	2	1	1	1	9,0	7,8
SH	3	1	1	0	6,2	11,6
IMP	0	4	0	1	10,8	10
CF	0	3	2	0	6,6	5,5
PL	3	2	0	0	3,6	7,3
ME	0	3	0	2	10,6	8,2

Table H.7: Team 7 Frequency and predominance of Team Roles

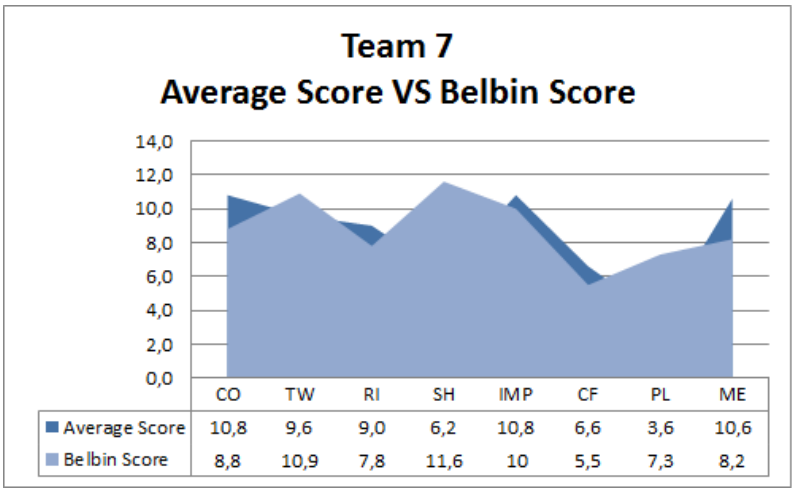

Figure H.7: Team 7 Average Score vs Belbin Score

Results						
Belbin Role	Frequency				Average Score	Belbin Score
	L	A	H	VH		
CO	1	2	2	0	8,6	8,8
TW	2	2	1	0	9,0	10,9
RI	2	1	2	0	7,2	7,8
SH	3	1	1	0	8,6	11,6
IMP	0	0	4	1	14,0	10
CF	1	0	3	1	7,8	5,5
PL	2	3	0	0	4,6	7,3
ME	0	2	2	1	9,8	8,2

Table H.8: Team 8 Frequency and predominance of Team Roles

Results						
Belbin Role	Frequency				Average Score	Belbin Score
	L	A	H	VH		
CO	0	2	1	2	15,4	8,8
TW	4	0	1	0	7,8	10,9
RI	4	1	0	0	4,2	7,8
SH	4	0	1	0	8,0	11,6
IMP	0	1	2	2	13,8	10
CF	1	1	2	1	7,6	5,5
PL	2	3	0	0	4,0	7,3
ME	1	2	1	1	9,2	8,2

Table H.9: Team 9 Frequency and predominance of Team Roles

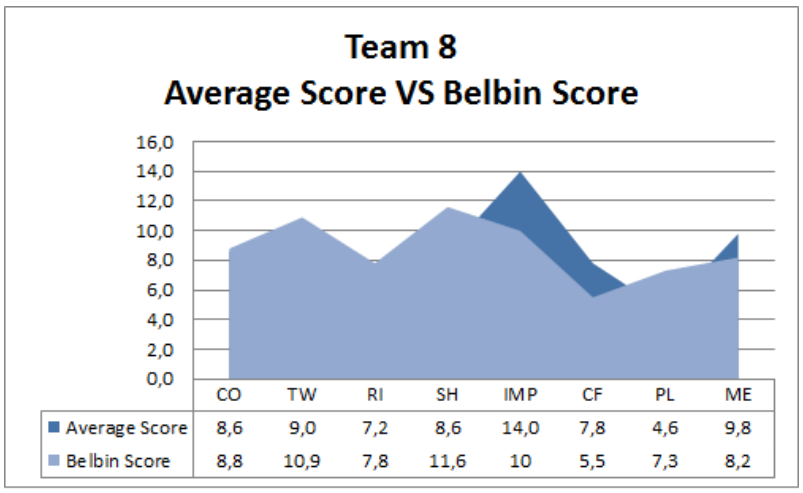

Figure H.8: Team 8 Average Score vs Belbin Score

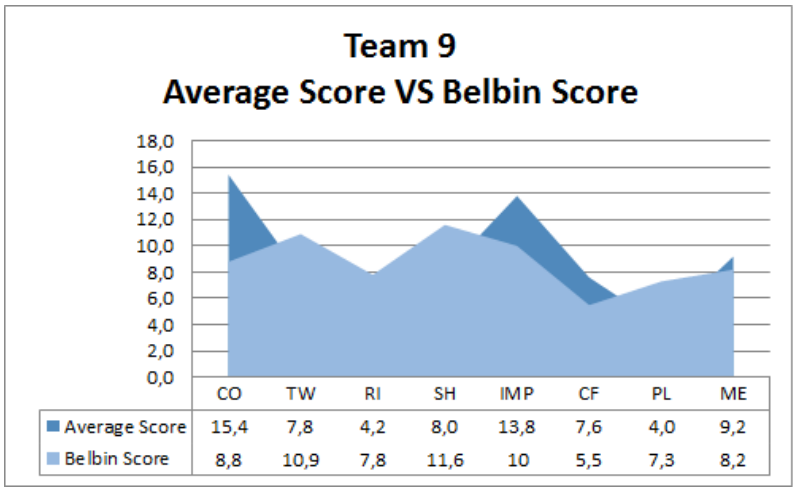

Figure H.9: Team 9 Average Score vs Belbin Score

Results						
Belbin Role	Frequency				Average Score	Belbin Score
	L	A	H	VH		
CO	1	1	3	1	9,2	8,8
TW	3	3	0	0	8,0	10,9
RI	1	4	0	1	8,5	7,8
SH	5	1	0	0	5,3	11,6
IMP	0	0	4	2	16,3	10
CF	0	3	1	2	7,7	5,5
PL	1	4	1	0	6,2	7,3
ME	2	2	0	2	8,8	8,2

Table H.10: Team 10 Frequency and predominance of Team Roles

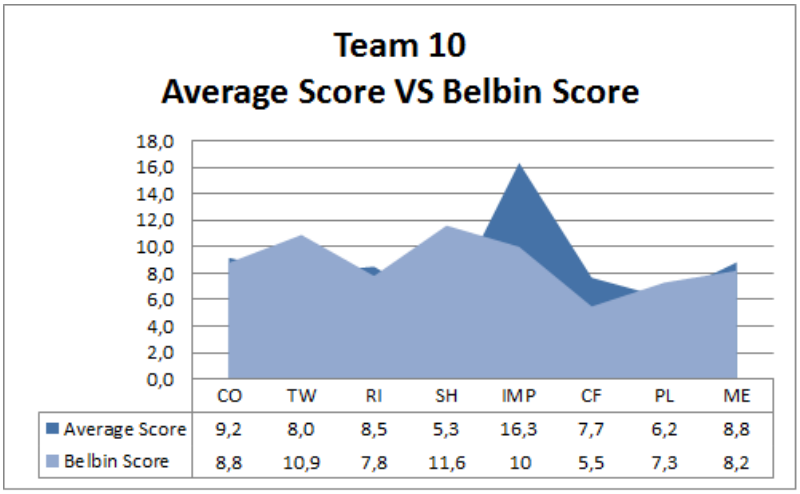

Figure H.10: Team 10 Average Score vs Belbin Score